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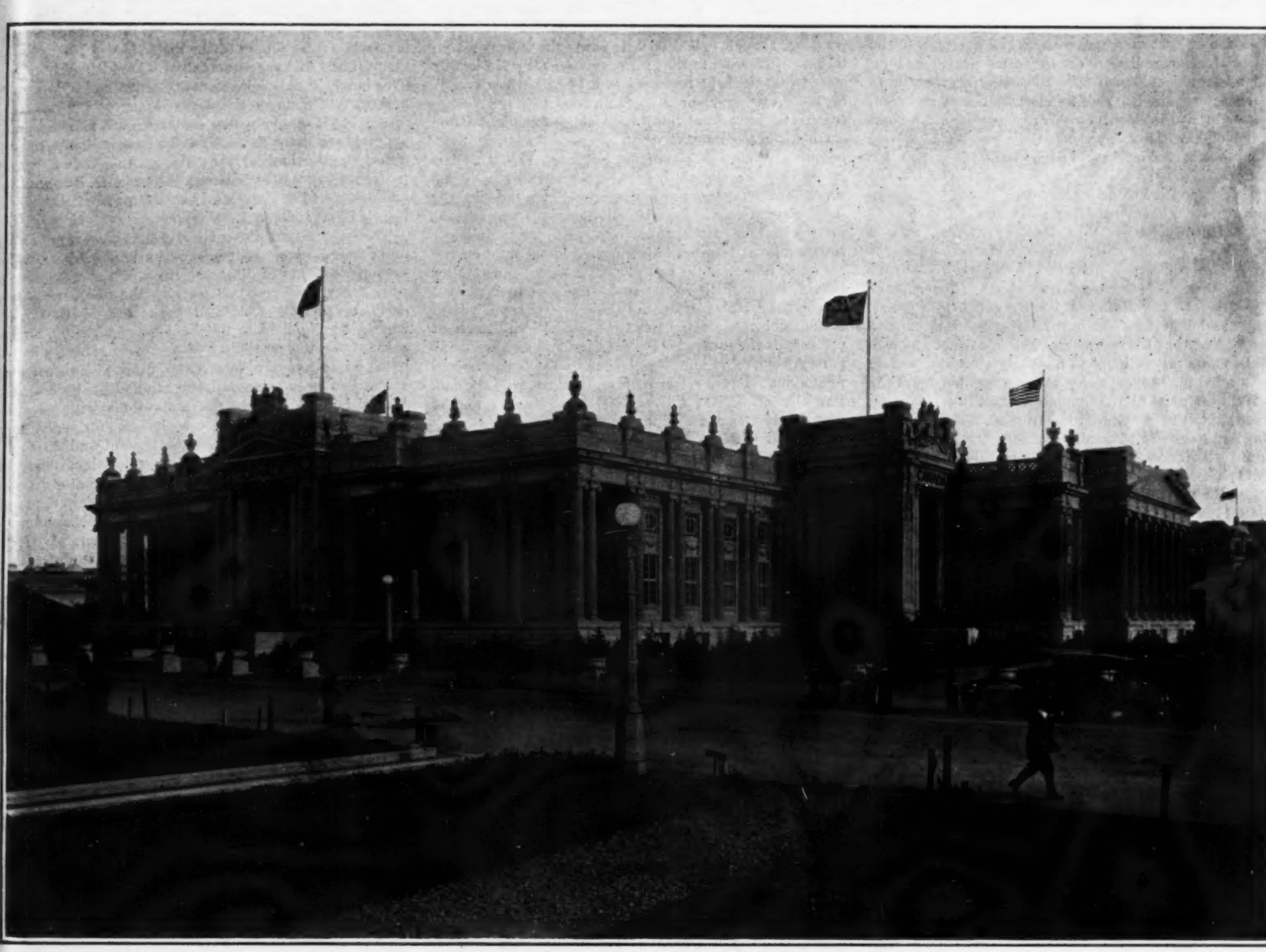


Canadian Pavilion at the Panama-Pacific Exposition.

A Nation in Perspective*

How Canada Has Brought Her Scenery and Resources to the Panama-Pacific Exposition

By Edward H. Hurlbut

In the method selected to display the variety of her resources, her scenic beauties and her topography, the Dominion of Canada has shown a compactness and a thoroughness in treatment and detail at the Panama-Pacific International Exposition not equaled by any individual participant, among either the nations or the States. It is an illustrated, visual argument in soil, in raw materials, in possibilities for the settler rather than an exemplification of finished products.

The Canadian pavilion—the second in size of all of the State and foreign buildings, California alone being larger—discloses a nation in perspective. To present graphically the dominant features of the Dominion the panorama has been used in a developed form. For instance, take the panorama of Vancouver harbor. Immediately in front of the visitor are the buildings of the city, actual replicas of Vancouver's waterfront. Next comes the harbor, thirty feet wide, where grain boats and traffic steamers pass back and forth to wharves and docks where puffing trains relieve them of their cargoes. Across the harbor are other buildings which shade into the landscape of the scenic artist with such wizardry that the eye is baffled in seeking the line of demarcation. The effect of distance, of immensity, is remarkably realistic.

Canada has here made an interesting study of graphic advertising. The psychological appeal that is sought in these diversified panoramas is intended for the prospective colonist. Each panorama speaks its definite message: *this is what we have in Canada.* Each panorama makes its own argument. The actual product is before you, the actual spot whence it came, and then the scenic artist presents the background and the environs. It is better than the old-fashioned panorama, infinitely superior to photography, and the next best thing to a personal visit to the provinces themselves. The scenic reproductions are of guaranteed fidelity. Canada has made of her national exploitation a science. For fifteen years one man has had charge of Canada's foreign participation at expositions. The result has been that Canada has learned what has "pulling power." In participating at the Panama-Pacific International Exposition Canada has utilized to an astonishing degree the amount of space in her pavilion. She has emphasized her dominant features. Just as the advertising man capitalizes his space by centering on facts so has Canada centered on her dominant economic features.

There are three main courts in the pavilion. In the middle court minerals are featured by actual samples in infinite variety. There are panoramas of Cobalt, the world's richest silver camp, and of Dawson City and the Klondike, the world's most thrilling gold producers. Around the walls of this court are dozens of small panoramas of Canadian life, each worked in grains and seeds in natural colors—a novel, inspiring conception.

There are three panoramas in the west court. One is of Vancouver harbor. The second is devoted to wheat, this one cereal being the center of the scores of cereals for which the dominion is famous. In the foreground are the cities of Port Arthur and Fort William. Railroad tracks are shown with trains operating over them to and from the huge grain elevators, built in exact form of the mighty elevators of the Lake Superior region. Back of the elevators is another touch of realism by way of modeled effects, and then the scenic artist takes up the picture and lays in the miles upon miles of undulating wheat fields.

Apples and peaches are the two fruits selected for the panorama devoted to fruits. In the foreground, apples are poured about in abundance, with glass containers showing the peaches, not yet in season. The set merges to show a typical orchard scene, and again the eye is carried by the subtlety of treatment over miles of fruit lands to the horizon. The "jointure" between

(Concluded on page 25.)

Photo-Electricity—II*

The Intimate Relations of Light and Electricity

By Prof. J. A. Fleming, F.R.S.

Concluded from Scientific American Supplement No. 2061, Page 7, July 3, 1915

In his second Tyndall lecture on "Photo-electricity," at the Royal Institution, Prof. J. A. Fleming dealt with the action of light on gases, with special reference to the action of solar radiation on our atmospheric and on radiotelegraphic phenomena. Reverting first again to the energy required to pull an electron out of an atom, he stated that the electron was, or represented, a certain charge of electricity, approximately one sixth of one trillionth of a coulomb, and as the product of a quantity of electricity by the voltage was work, it was customary to express the work done in extracting an electron as the product of the charge and a certain voltage, known as the ionizing voltage. This ionizing voltage ranged from about 2 to 12 volts. It was greater for electro-negative atoms, which did not give up their electrons readily, than for electro-positive atoms. For gaseous oxygen it was 9 volts, or $9 . 16/10^{20} = 144/10^{20}$ joules, about 15 billionths of an erg. Experimentally it had been proved that the energy required to extract a photo-electron was proportional to a certain constant, and to the minimum frequency (or maximum wave-length λ in Angstrom units (A.U.) capable of liberating electrons; it was explained in the first lecture that the light vibrations had to exceed a certain frequency (or keep below a certain maximum λ) before any photo-electric effect would take place. The product of the ionizing volts and of the maximum λ was found always to be of the value 11,000 or 12,000. In the case of the electro-positive metal sodium the ionizing voltage was 2.1, and the λ (as stated last week) was 5,500 A.U., i. e., waves of relatively large wave-length falling within the visible spectrum. In the case of oxygen, an electro-negative element, the ionizing voltage was high, 9 volts, and the ionizing wave-length therefore 12,000/9 = about 1,350, which meant that oxygen could only be ionized by light from the ultra-violet end of the spectrum of very small λ.

The experimental investigation of the ionization of gases by light involved many difficulties, because there were so many possible spurious effects—surface films on the walls of the vessels, dust in the gas, ionization due to the bubbling of the gas through liquids, etc. The containing vessels could not be made of glass, moreover, as glass was not transparent to ultra-violet light; even quartz was only transparent to light down to $\lambda = 1{,}850$ A.U. To exemplify this, Prof. Fleming passed air, filtered through cotton-wool, through a quartz tube, in which the air was exposed to the radiations from a spark-gap, and then through a tubular condenser, consisting of an inner metal tube joined to a charged electroscope and an outer earthed tube; hardly any photo-electric effect was observed, because the quartz was not sufficiently transparent. But when the hot gas from a burning candle was sucked through the same apparatus, the electroscope was discharged, both when charged positively and when charged negatively, because the hot flame contained ions of both signs. Air ionized by light should always contain ions of both signs in equal quantity; otherwise the effect might be due to dust particles or other causes. White fluospar (fluorite) was the only material for containing vessels sufficiently transparent to ultra-violet light.

Prof. Fleming then turned to the question whether the sunlight emitted rays capable of ionizing the atmosphere. The light which reached the earth from the sun and from stars (Vega) did not, he said, contain any rays of λ less than 2,950 A.U. (Huggins and Cornu). But that was because the atmosphere, and especially the oxygen, absorbed shorter waves. The sun itself gave rays of much smaller wave-lengths. Speaking at some length of the sun, he said the sun was probably a mass of gas (of high density 1.4) formed of many concentric envelopes. The light we received came from the photosphere (a mass of glowing carbon flakes or particles at 6,000 deg. Cent.), which gave the continuous spectrum and emitted torrents of negative electrons like the carbon or metallic filament of his (Dr. Fleming's) oscillation valve. Outside the photosphere was a layer of metallic vapors, 500 miles in thickness, producing the Fraunhofer lines (reversing layer); further out the chromosphere of vapors of hydrogen, helium, and calcium, from which red prominences shot out; beyond that the attenuated atmosphere of the corona, and much further out still, in the plane of the ecliptic, the lens-shaped, still more attenuated mass of the zodiacal light. The electrons, projected from the photosphere through the envelopes, condensed molecules of matter around themselves and formed negative ions, and when these ions were below a certain size they were driven outward by the light pressure, though pulled back towards the sun by gravitation. Referring to the energy relations, Prof. Fleming stated that sunlight imparted to a black surface energy of $1.47 . 10^{6}$ ergs, or 2.1 gramme-calories per square centimeter per second, and 1 cubic mile of sunlight at the earth's surface contained an energy of 14,720 foot-pounds (Kelvin's first estimate had been 12,050). The intensity of the sunlight near the sun's surface was 46,000 times greater. The pressure exercised by the sunlight (as a general consequence of wave motion) was 58 tons per square mile at the sun's surface, and 2.8 pounds per square mile at the earth's surface, and the light energy per cubic mile near the sun was 302,200 foot-tons. Now gravitation near the sun was 27 times greater than it was on the earth's surface; but the gravitation pull varied as the cube of the diameter of the particle, and the light pressure as the square of the diameter, and for very small particles the repulsion from the sun by the light pressure predominated over the gravitation pull towards the sun. Particles of 13,000 A.U. = 0.00013 centimeter and of unit density (as dense as water) would just be balanced, and smaller particles would be pushed away from the sun. According to Schwarzschild, particles of 1,600 A.U. (twice the thickness of the thinnest gold leaf procurable) should undergo the maximum repulsion, and would be pushed away from the sun with an acceleration of 2 kilometers per second per second. Prof. Fleming, like Arrhenius and Poynting,[1] had, he said, made calculations on the light pressure, and had found that particles of solar dust of diameters of 1,600, 5,000 and 10,000 A.U. would want 25, 55, and 112 hours to travel from the sun to the earth at velocities of 1,700 kilometers, 800 kilometers, and 350 kilometers per second, and would enter the atmosphere of the earth with energies of 540,000, 120,000, and 45,000 horse-power hours. The energy was enormous, owing to the great velocity, and an amount of solar dust that could be carried about in the pocket would possess sufficient energy to propel a large battle-cruiser (30,000 horse-power) for eighteen hours.

These negatively-charged dust particles entering the upper atmosphere, which consisted of hydrogen and helium, were deflected in spiral paths by the magnetic force of the earth, and accumulating in two rings about the magnetic poles, caused the auroræ and the magnetic storms, which, again, were closely connected with the sun-spot activity. According to Arrhenius, Maunder, and Riccò, there was frequently an interval of from 20 to 45 hours between the meridian transit of a sun-spot and a magnetic storm, and that lag would correspond with Dr. Fleming's own calculations as to the time required for the negative ions to reach the earth from the sun. There was certainly sufficient reason to assume that the upper atmosphere was invaded by negative ions which imparted conductivity to it, though that conductivity was difficult to estimate. An additional ionization of the upper levels of the atmosphere was produced by solar light of 1,400 A.U. and less, but only in the illuminated half of our atmosphere. As soon as the sunlight was withdrawn, most of the separated ions would recombine. There was hence a permanent and a variable ionization, as would presently be mentioned again. The ionization at lower atmospheric levels could not be due to direct solar action, but might be due to dust, splashing of rain and ice particles, radioactivity, etc. By means of unmanned balloons, observations had become possible up to the 20-mile level; wireless telegraphy had drawn fresh attention to the phenomena at higher levels.

When Mr. Marconi observed in 1902 that he could signal across the Atlantic to much greater distances (1,500 miles and more) at night than at day (700 miles, wave-length 2,000 feet or 3,000 feet), he suggested a possible photo electric effect of daylight. That suggestion had not met with favor then, because the difference had only been observed at long ranges; but Prof. Fleming thought the suggestion worth considering. The Hertz-spark effect (first experiment described in the first lecture[2]) did not depend upon the material of the spark balls (while the material was of importance for the ordinary discharge of electrons from polished plates by light), as long as the balls were charged to nearly the discharge potential; then electric waves caused the spark to pass readily. The antennæ were in that condition, and this Hertz effect was therefore possible. That the intensity of the current received by the antennæ varied inversely as the square of the distance had been proved theoretically and experimentally by Duddell and Taylor. This law held only for a distance of 200 miles, however; beyond that distance the received current fell off much faster than it should by day, and was much more irregular by night than by day. That had been shown by the observations which Dr. Austin, of the United States navy, made in 1910 between the cruisers Birmingham and Salem and the land station at Brant Rock, the wave-length being 1,000 or 1,500 meters.

The sphericity of the earth had first been supposed to make long-distance radiotelegraphy impossible. In the first experiments of 1901 the ratio of the wave-length used (2,000 feet or 3,000 feet) to the diameter of the earth (42,000,000 feet) had been that of the wave-length of green light to the diameter of a cherry, and to account for the possibility of the early range, and the much larger ranges of later years, diffraction of the long waves had been suggested and studied by Poincare, J. W. Nicholson, Rybczynski, and others with negative results. Resuming these calculations for very long waves of 2,000 feet, H. M. McDonald and A. E. H. Love had recently come to the conclusion, however, that diffraction would account for the greater part of the day effect. Dr. Austin had tried to explain the rapid diminution in the intensity by some atmospheric absorption. Three questions thus remained open: 1. If the normal daylight range were possible owing to diffraction, why was the night range greater and more irregular? 2. If diffraction did not account for the day effect, how were signals possible round an earth quadrant? 3. How were the abnormal effects at the transit from day to night to be explained?

Prof. Fleming then dealt with these sunset and sunrise peculiarities and stray effects, referring chiefly to Mr. Marconi's Royal Institution lecture of June, 1911, which we noticed at the time;[3] we should also direct the attention of our readers to our reports on the discussions on "Radiotelegraphy," before the British Association, at Dundee and at Sydney, last August.[4] The only theory that gave a clue to the explanation of the effects, the lecturer thought, seemed to be the theory of ionic reflection, which was based on the theoretical proof of Dr. Eccles, that in a dielectric, populated with heavy ions, there would be a slight increase in the velocity of the electric wave, and hence a bending of the electric rays, which might be described as an inverted mirage. When the earth and the air immediately above it became very hot through the sun's heat, light rays entering the layer obliquely became curved by refraction, and the lower rays (next to the earth) gained on the upper rays until they were totally reflected, and entered the eye in the inverted order, so that objects appeared inverted. By inverting a slide illustrating mirage the Eccles effect might be explained. The two upper layers of the atmosphere were, as mentioned, layers of variable or diurnal variation, and, above it, of permanent ionization. Both contained ions, due to the ultra-violet light and to solar dust. There was no sharp boundary between the two layers; but they would bend electric rays down as high clouds reflected the light of the setting sun. When the sun set, the advancing shadow of the earth allowed the separated ions to recombine; hence the sunset and sunrise effects, which could be traced all through the year, especially when the two stations were lying east and west, so that the advancing shadow intervened between transmitter and receiver. But the ions were not totally suppressed by the withdrawal of the light in the lower diurnal layer, which remained ionized in patches; hence the irregularity of the light effect. A ray proceeding upward in the direction A, B (Fig. 1) would in day time be bent and reach the earth again at C; at night time, when the diurnal layer was party destroyed, the ray would proceed higher up into the permanent layer and would reach the earth at D, further away from A than C; that would account for the increased night range. In illustrating the phenomena, Dr. Fleming made use of a slide on which two points about 45 degrees apart (Clifden and Glace Bay) were marked as transmitting and receiving stations on a card which could be turned; the stationary earth's shadow fell over both the layers mentioned, but did not blot out the upper, permanent layer. At the border plane between light and darkness

* Reproduced from *Engineering*.

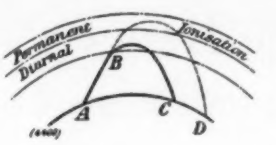
[1] See *Engineering*, vol. lxxviii., p. 364.

[2] See page 6.

[3] *Engineering*, vol. xci.; p. 763.

[4] *Engineering*, vol. xciv., p. 349, and vol. xcviii, p. 580.

there would be an irregular stratum of ionized and unionized air which might reflect or obstruct an electric ray, just as an emulsion of oil and water was opaque to transmitted light, but reflected the light, until it had settled and became transparent again. That was the sunset and sunrise effect already alluded to. The boundary plane seemed to act as a reflector (increasing the signal intensity) when it was behind the transmitter, and again when it was behind the receiver; when between the two it acted as a weakening absorber. Further to elucidate this point Prof. Fleming placed an incandescent lamp L, a semi-transparent photometer screen S, and a plate of glass G, in the order either G, L, S or L, S, G; in both positions the light reflected from G increased the brightness of S.



In conclusion, Prof. Fleming remarked that many peculiarities of radiotelegraphic propagation remained obscure. In order to collect more facts all over the globe, he had, in 1912, suggested the appointment of a British Association Committee, of which Dr. Eccles was secretary. Unfortunately, the war had interrupted that useful work.

Problems of Geographic Influence*

Differentiation of the White Race

It's a long way from the primitive man to the differentiation of the white race, from the white beginnings to Briton, Anglia, Norway and Normandy, from Anglia and England to California and Puget Sound. Along this ancient and devious path our ignorance of the inner laws of human development is appalling. We see man, and earth, something called race, race continuity, one physical environment after another, human environments with innumerable mixtures of blood, in infinitely various compounds, in the grand march of humanity to one world center after another. The result, to carry out our illustration still, is the Pacific coast man, domestic, industrial, political, social, moral. It will take cautious steps and many torches to pick our way back along the road by which he came.

Let us take another example in emphasis of the difficulties which beset us—an analysis of the causes of Japanese character. Mental alertness has been asserted to be the chief trait of the Japanese. This must have originated in accordance with biological laws, in spontaneous variation, in mixture of races, or in environment, or we might add, by a combination of these. It is tentatively held that however this quality arose, it has been preserved by environment: first, by insularity, giving familiarity with the sea, saving from wars, intermixtures and invasions, in distinction from a continental land, like China; second, by physical features, affording small areas of cultivation, promoting industry, a land of such richness as to give certainty of reward, without drought or flood to destroy the prudent as well as the thriftless. Third, there comes climate, following a supposed law that the progressive lands are in the cyclonic domain of the Temperate zone.

This seems simple, interesting and suggestive, but is it true? Is mental alertness the chief trait in Japanese efficiency? Droppers, sometime professor in the University of Tokyo, thinks the secret of success is in the structure of society, devotion to family life, or to tribe and nation, the corporate *versus* the individualistic.[1] Dyer emphasizes community but denies that the main ability is in imitation. Loyalty and intellectual ability are the basis of achievement. Another authority marks the Japanese as sober, intelligent, enduring, patient, industrious, polite, skilful, ready to assimilate, not devoid of original genius.[2] Yet another says he is patient, persistent, cheerful, versatile, quick-witted, enterprising, original, imitative, progressive, industrious, artistic, humorous, cleanly, polite, honorable, brave, kind, calm, self-contained.[3] Whether any good human qualities have been left out of these catalogues, we do not know, but we are at least left in doubt as to what the main national trait is.

But suppose it is mental alertness. Would insularity make it or keep it? Miss Semple avers that insularity breeds conservatism, a quality that does not seem to be indissolubly tied to alertness. Insularity may give familiarity with the sea, but perhaps not greater than is true of the Dutch, who are not insular, and we do not think of the Dutch as distinctly alert. Insularity has not kept Japan free from invasion, though there have been periods of seclusion. And the modern Japanese are "a very mixed people," Mongolian, Caucasian, Malay, and some say an infiltration of Negrito. If insularity breeds alertness, what other factors have apparently swamped this tendency in Madagascar, Iceland, Sicily, Cuba, and Hawaii?

Nor can we be sure of the effect of small areas of rich cultivation and certain reward. Industry we can predict and a degree of comfort, but can we say more? Why not as well expect the Belgian farmer or the farmer of the Paris basin, or of the county of Norfolk to be mentally alert? Moreover, most Japanese are in a low state. "We imagine them" (the Japanese) "as intellectually homogeneous," but there are "five million highly cultivated people and nine times as many of lower type . . . the mighty mass still pagan, stolid, low in the scale of evolution."[4]

This little empire is indeed a good place in the temperate zone, and so are China, Switzerland, Spain, Austria-Hungary, Germany, France, and too many others to make the criterion of distinctive value. The inference for precise, detailed and prolonged research need not be elaborated.

We have already spoken of certain related sciences as supplying motives to the human geographer. We turn now to examine the geographer's proper sphere of activity in relation to these sciences.

Our references to the race problem might seem superfluous, for if this field belongs essentially to the anthropologists, what right has the geographer there? Here we seem at once to need a definition of geography. But the present writer will not try to go where angels have trod with devious and faltering steps. Sometime we shall have a definition of geography, but not now.

Ratzel makes a sweeping criticism of Buckle when he says that *evolution* is unspoken by him.[5] The great geographical philosopher of Leipzig made it forever imperative for us to "go back into the past." He speaks of differentiation, of bequeathed influences, of the migration of developed traits—he never lets you doubt that he is moving into the realm of Darwin. So the geographer, if he touches man at all, and the more if he opens the question of geographic influence, must be in daily contact with the principles of biological evolution, so far as the specialists have mastered them. I will not try to say how far he may supply useful data to the biologist; sure it is that human anatomy, physiology, and psychology must be relied upon for light on the early (as well as late) stages of mankind. Should not this field be turned over to the anthropologist?

The first answer is that so far as environmental factors are concerned, the geographer alone is responsible for the knowledge of the total physical complex which the earth affords. But when this comprehensive survey of the physical geography has been supplied, do not the geographer's duties, and even his rights, cease? If so, and if we must leave the action of environment to the anthropologist, to what kind of an anthropologist? The somatologist perhaps. The somatologist studies the natural history of the body. This is highly important, but it is only one point of view. He also studies man in his physiological development, but this is also partial. Your anthropologist may be primarily a psychologist, a philologist, or a student of early arts or of comparative religion. Or he may be an ethnologist studying the physical features, mental traits, linguistics, practical arts, legends, and religions of a single tribe or people.

To which one of these will you look for a world view of the influence of environment on early or half-developed man? For your answer go through all the reports and books of the anthropologists, rich as they are, and tell me the result. In the nature of the case, the anthropologist, even if he could command all the departments of his own science, is not in a position to organize the principles of the influence of an earthwide environment on man. He offers indispensable materials and he may find other unities in his field, but the inclusive bond of world environment belongs to the geographer.

Suppose we say that we do not need anthropologists because there are anatomists, physiologists, psychologists, philologists, and students of art and religion. The answer is that anthropology aims at the natural history of man as a whole. The specialists work indeed too often in small and isolated fields and not always with the casual and comparative principle in full view. But man, the bond, is there, and the science receives its justification. In like manner, why should there be geographers, for there are geologists, meteorologists, oceanographers, astronomers, botanists, and zoologists? We say because there is no other to organize the data of all these sciences in relation to the whole earth, as we see it and know it.

Taking the like case—there are anthropologists of many sorts, historians of several kinds, sociologists, economists and technologists in ample variety. Why a human geographer? Because there is no other to exhibit the human kind (not now but in some coming day) in its casual and distributional relation to the earth and its forces viewed as a unity.

* Abstracts from the address of Prof. Albert P. Brigham, President of the Association of American Geographers, at the eleventh annual meeting at Chicago.

[1] Garrett Droppers, "The Secret of Japanese Success," *Jour. Race Devel.*, ii, 424.

[2] V. Dingelstedt, "Ruling Nations," *Scot. Geog. Mag.*, 27, 365.

[3] Writer in New Inter. Ency., Art. "Japan," 335.

[4] W. E. Griffis, "The Japanese Nation in Evolution," 271, 386, 389-90.

[5] "Anthropogeographie," i, 97-98.

How a 25 Per Cent. Saving Was Made

A few years ago the writer supervised an isolated power plant which was entirely too large for the requirements of the factory; the load factor was only about 18 per cent of the plant rating at that time. The losses as a consequence were tremendous. The engine was a simple Corliss type belted to an alternating current generator; the boilers were of the horizontal return tubular high-pressure type; the engine was designed to operate at 108 revolutions per minute and was operated at this speed when the writer took charge. He ordered the necessary generator and engine governor pulleys to drop the speed to 82 revolutions per minute; made tests to determine what steam pressure to carry at various loads in order to secure the most economical cut-off on engine. The drop in speed of engine and reduction in boiler pressure to meet load conditions, resulted in a saving of 25 per cent of fuel consumed. This saving was entirely due to an improvement in engine performance by maintaining the most economical point of cut-off.

The rate of evaporation was at this time only approximately 3 pounds of water per pound of fuel; evidently then more load was necessary to improve the boilers' efficiencies. The factory was fully equipped with machinery and workmen, hence there seemed no opportunity to secure more load in the shop. But gas was used for heating the Japan baking ovens, and the writer designed and built in the shop an electric baking oven. It was so successful that six more were built within a short time. This electric oven load brought the total load factor up to 41.4 per cent of plant rating, and the boilers with this load evaporated 6.5 to 7 pounds of water per pound of fuel. As the rate of evaporation more than doubled and the load was practically doubled, it required no additional fuel to carry the load of the ovens. The work of the electric ovens gave far superior results to that of the gas ovens, and further saved between $5 and $6 per day for gas.

Tests proved that the best furnace efficiency was obtained when the rate of combustion was about 18 to 20 pounds of screenings per square foot of grate area per hour. An increase in the combustion rate showed a more marked loss than a decrease to certain limits. Previous tests on the boilers showed that their evaporative efficiencies fell very rapidly below one half load, whereas the curve of evaporation rate was fairly flat from ½ to 1¼ load.

The load on one boiler tended to give higher boiler efficiency than when carried on two boilers, but with one boiler the furnace was forced to burn 35 to 40 pounds of fuel per square foot per hour, resulting in serious losses of furnace efficiency, hence it evidently was a stack problem—forced draught or more grate area. A higher stack would have increased the economical rate of combustion, or a suitable forced draught would have done so. But an increased grate area seemed worthy of trial and new grates having 20 per cent more area were installed in one furnace; this resulted in a decided saving during the day load, but a loss during night run when the load consisted only of maintaining steam on the fire pump for sprinkler system. The net gain, however, soon paid for the cost of installing the larger grates. The company was at this time contemplating a move to another city and for this reason the writer did not recommend a higher stack, which was after all the proper solution of the problem, as it is in a great many plants.—*S. J. H. White, in the Iron Age.*

The Range-Finder*

How Distances Are Measured on the Battlefield

The Range-finder, as the name implies, is an instrument for ascertaining the distance to any visible point on the landscape from the position occupied by the observer or operator, who is known as the Range-Taker. Range-finders are of two types: the double-observer type, such as the Mekometer, or Telemeter, used in the British service; and the "one-man" type. In both cases the distance to the object (or range) is found by triangulation, the angles being taken from the ends of a known base—a very short base of about three feet in the case of the one-man range-finder, and a normal base of fifty yards for the Mekometer artillery instrument, and twenty-five yards with the infantry instrument.

Fig. 1 illustrates the Mekometer instrument in use, and shows clearly the base, which is the known length of cord stretched between the two instruments, held by the two observers. The man, marked *A*, with the reading instrument sights an object (in this case, a church) of which the range is required. The second man, marked *B*, advances until he can, through his right-angling instrument, see both the same object and the sighting-vane on *A*'s instrument. When these two coincide, he shouts "On," and *A*, by turning the range-drum on his instrument until he also makes the reflection of *B*'s sighting-vane coincide with the object seen in the instrument, is then able to read the range off the range-drum in yards. This instrument was employed at the time of the South African War, but owing to its having a very long base (25–50 yards), and requiring two men to operate it, was found extremely difficult to use because of the lack of cover. In one-man range-finders the base is a bar, or frame of short length, with a telescope mounted at each end, and having an eye-piece in the middle into which the rays are reflected. With this instrument, measuring only 37 inches long by 3 inches in diameter, and weighing 5½ pounds, one man is able rapidly and accurately to take ranges of objects up to 20,000 yards distant. In taking the range the operator directs the telescopes of the instrument on to a clearly defined object, and by turning the range-drum (Figs. 3 and 2) the right-hand telescope is inclined inward until the two images seen in the central eye-piece coincide. The range given on the drum can then be read.

* The *Illustrated War News*.

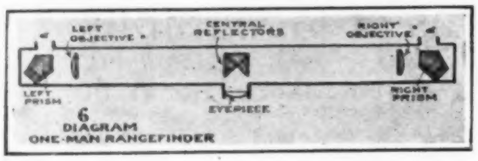
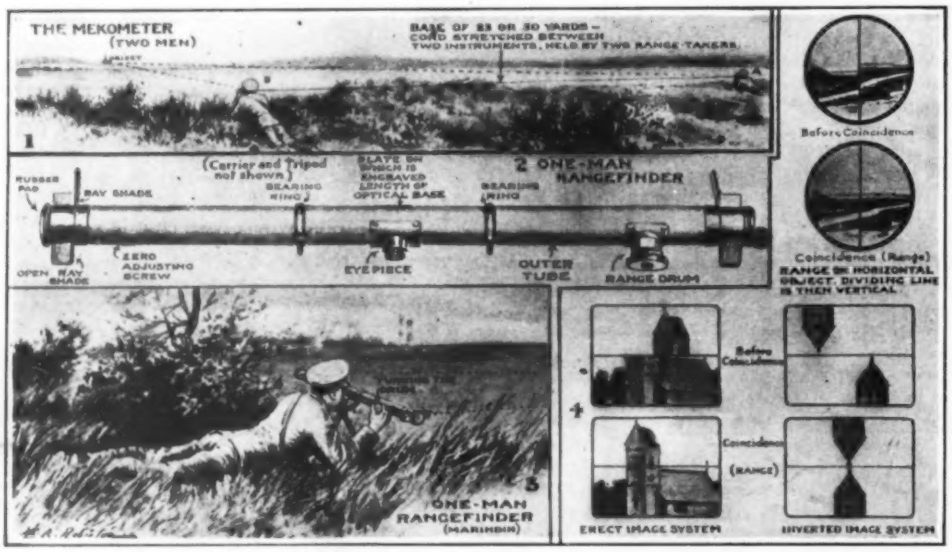
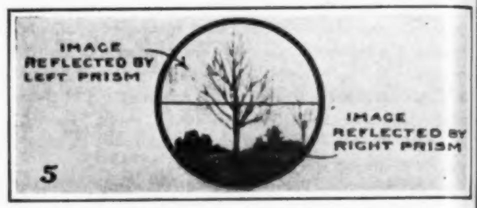


Diagram of construction of a one-man range-finder.



Types of instruments whose accuracy and manipulation may cause victory or defeat.

As explained in the article, Fig. 1 shows a range-finder known as the Mekometer, that needs two men to work it. Fig. 2 shows a one-man range-finder; Fig. 3, the same in use; and the smaller diagrams show the images seen respectively when the instrument is held horizontally and vertically. An artillery range-finder must be a good horseman, have a good eye for country, keen eyesight, and, above all, steady nerves. Any nervousness while taking a range may easily give an error of a hundred yards or more, which might make the difference between victory and defeat. The advantage is with the battery which drops the first shell on the right spot at the correct range.



A view through a one-man range-finder.

With the upper section seen through the left hand telescope and lower through the right hand.

A typical one-man range-finder is illustrated, diagrammatically, in Fig. 6. It shows the two telescopes already mentioned running at right-angles to the single eye-piece fixed in the center of the range-finder tube. The rays from the distant object entering the end apertures (a a) of the range-finder base, are received by the left and right prisms and transmitted through the left and right objectives towards the central reflectors, which reflect them outward through the eye-piece. The observer, looking into the eye-piece, will see the field of view divided by a thin "dividing line." Anything seen above this horizontal line is formed by the left-hand telescope, and that seen below the dividing-line, by the right-hand telescope (Figs. 4 and 5). The view will be similar to the images shown in Fig. 4, *before coincidence*. By turning a drum, these images can be brought into coincidence, and the correct range can be read from the range-drum.

The Early History of Opium

The medicinal properties of poppy juice date from a remote period. Recalling the highly developed culture of the ancient Egyptians one is inclined to imagine that the narcotic properties of opium were known to them; but the investigations of Unger (1857) have failed to trace any acquaintance with opium in Ancient Egypt, and Dr. Ember, of the Semitic Department of Johns Hopkins University, knows of no reference to it in Egyptian literature. According to some Hebrew scholars, there is a reference to poppy juice in the Bible. In several passages in the Old Testament the word *rôsh* is mentioned. Prof. Haupt is convinced that *rôsh* means the poppy, and so also is Prof. Post. In the Talmud we have one reference to opium, under the name *ophion*, but that word was clearly borrowed from Greek. In the classical Hindoo literature there is found no reference to it. From the time of the Mogul Conquest on there appears a word, ***Khash-khash***, which means poppy-seed, and ***Khash-khasharasa***, juice of the poppy. In this it is easy to recognize our modern word *hashish*; and so it seems that at that early date the narcotics opium and cannabis indica were confused with each other. The original home of the poppy was in Asia Minor. From there it was carried to Greece at a later period.

It is not at all certain whether Hippocrates was acquainted with the juice of the poppy. According to Wootton, he refers to a substance called *mecon*, to which he attributes a purgative as well as narcotic action. Some think that it was opium; others believe that he was referring to another plant. In any case, he made but very little use of the drug. The first authentic reference to the milky juice of the poppy we find by Theophrastus at the beginning of the third century B. C., when he speaks of it as meconion. Scribonius Largus, in his "Compositiones Medicamentorum," about the year 40 of the present era, describes the method of procuring opium from the capsules of the poppy, and about the year 77 of the same century Dioscorides makes a distinction between the juice of the capsules and the extract of the whole plant. He describes the method of incising the capsules, and refers to adulterations of the drug with the milky juices of other plants, so that it is evident that the collection of opium was quite an industry in Asia Minor at that time. Pliny devotes some space to a description of opium and its medicinal use, and the drug is mentioned repeatedly by Celsus in the first century and by numerous other Latin writers. Galen spoke enthusiastically of the virtues of opium confections, and the drug was soon so popular in Rome that it fell into the hands of shopkeepers and itinerant quacks.

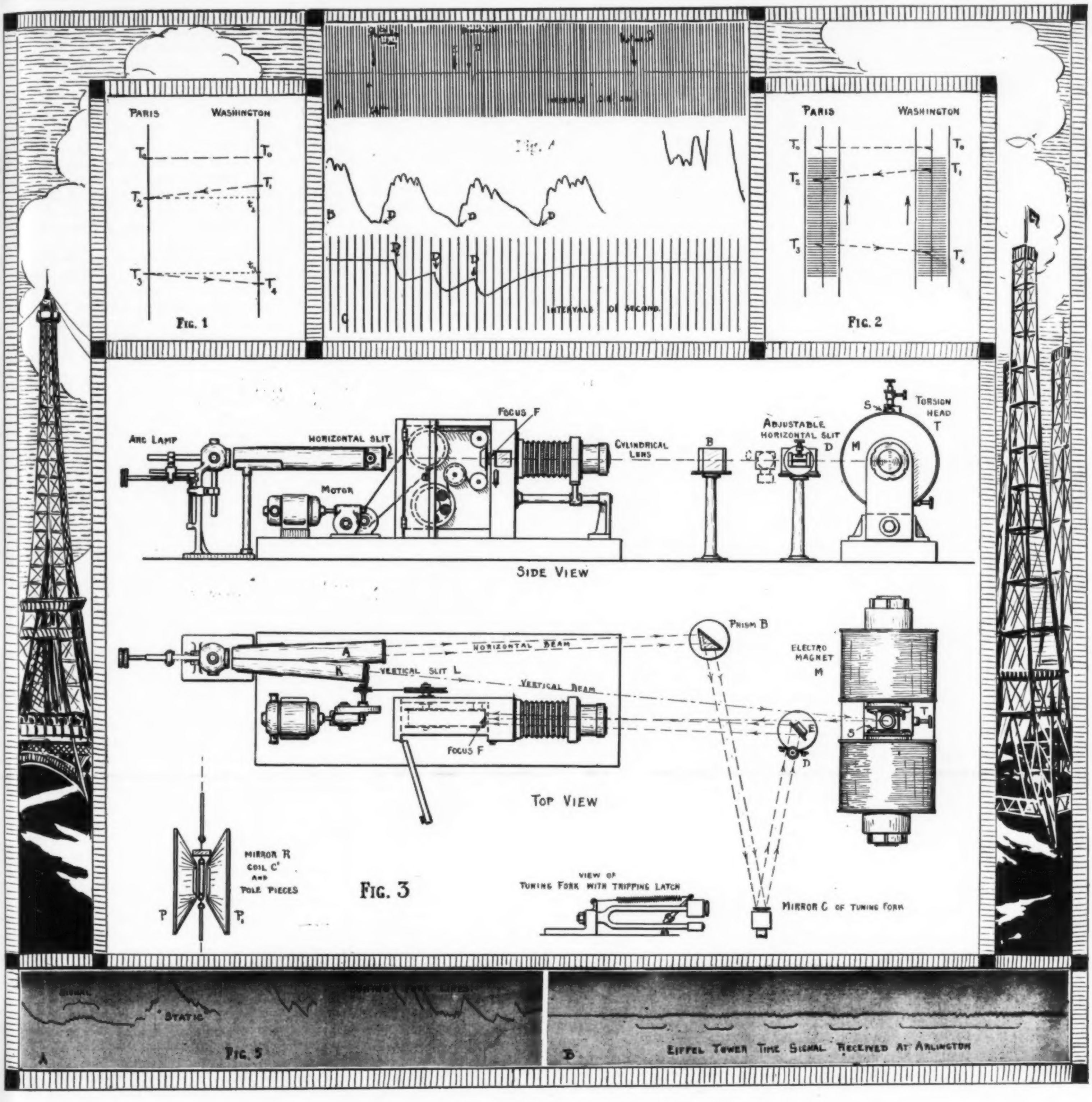
The introduction of the drug to the natives of the East was through the Arabs, and in the first instance to Persia. Its introduction into India seems to have been connected with the spread of Mohammedanism.

The Arabic physicians used opium very extensively, and even wrote special treatises on some of its preparations. The earliest mention of opium as a product of India is by the traveler Barbosa, in 1511. A Portuguese historian, Pyres, in a letter to Manuel, King of Portugal, in 1516, speaks of the opium of Egypt and Bengal.

Opium is supposed to have been brought to China first by the Arabs, who are known to have traded with the southern parts of the empire as early as the ninth century. Later, says *The Journal of the American Medical Association*, the Chinese began to import the drug in their junks from India. It was not before the second half of the eighteenth century that the importation of opium began to increase rapidly through the hands of the Portuguese, and a little later through the famous East India Company. In 1770 the English established an opium depot in Lark's Bay, south of Macao, and the traffic rapidly increased, so that very soon the Chinese authorities began to complain, and in 1820 an edict was issued forbidding any vessel having opium on board to enter the Canton River. A system of contraband followed, then political friction between England and China, and the so-called Opium War, which culminated in the Treaty of Nanking (1842) by which five ports of China were opened to foreign trade, and in 1858 opium was admitted as a legal article of commerce. By that time the vice of opium smoking had spread like a plague over the gigantic empire, and become so deeply rooted that, in spite of innumerable edicts and decrees, all efforts to check its growth have been powerless.

Poles for Electric Transmission Lines

In laying out an electrical transmission line the question of poles is an important one, for not only is the question of the first cost involved, but the character of the district through which the line runs must be considered in relation to the cost of maintenance. Wooden poles are often the cheapest, but are not always strong enough to properly support heavy modern lines, in which case it becomes a question between steel construction and reinforced concrete. In some localities there is such a volume of destructive fumes discharged into the atmosphere as to seriously affect steel structures, and the cost of repairs may be very heavy, even where the best protective paint is used, and if the proper wooden poles cannot be obtained at a reasonable cost it is often found desirable to use reinforced concrete construction.



Apparatus used in determining the velocity of Hertzian waves.

The Velocity of Hertzian Waves

Long-Distance Measurements; Apparatus Used and Results Obtained

By H. E. Saunders, Ens., U. S. N.

In the Scientific American of August 2nd, 1913, appeared an article which outlined in a general way the campaign, then forthcoming, to determine the exact difference of longitude between the observatories of Washington and Paris, by means of radio-telegraphic signals and the method of coincidences. The powerful Government stations at Arlington, Va., and the Eiffel Tower, in Paris, were to be used, and if the conditions proved favorable a supplementary part of the work was to include a measurement of the velocity of Hertzian or wireless waves between the two stations, in order to determine just what ratio this velocity bore to that of light waves.

Ever since the discovery of these waves by Hertz, and their application to wireless telegraphy, it has been universally considered that they were of the same nature as light waves; that they were transmitted through the same medium of ether in the same vibratory manner, and that they differed from the latter only in respect to length. With these assumptions it was natural to suppose that the speed of propagation of the two would be identical; whether this would hold true for a 2,500-meter Hertzian wave traveling some 4,000 miles along the earth's surface, and for a wave of red light, say of length 0.00075 millimeter (about one three-billionth of the radio wave) and traversing the distance from one side of the solar system to the other, would be very interesting and valuable information.

Before any of this actual experimenting had been done, however, several letters appeared in the columns of the Scientific American, suggesting methods by which this measurement might be made. Although the schemes proposed embodied the correct principles, they were insufficient and impractical for lack of practical mechanical apparatus. In this article will be explained the system subsequently employed, and it will be shown how, with very ingenious apparatus, it was possible to measure time intervals for this speed determination with an almost unheard-of accuracy.

The method suggested by Mr. Riggs in his letter of November 15th, 1913, of employing two chronographs to register the signals and of sending out almost simultaneous signals from the two stations, was very satisfactory as to theory, but equally as impracticable as to operation, for no chronographs could be constructed which would function with the exceedingly small currents received. Furthermore, it was out of the question to fit both stations with switches which would throw the antenna from the "sending" to the "receiving" position in the fraction of a second, therefore the dashes "flashed back" had to be some seconds apart.

Another plan suggested by Mr. Bliss, in the SCIENTIFIC AMERICAN of January 10th, 1914, called for the use of a mirror galvanometer and a photographic registering machine—apparatus which, in a modified form, was actually in use at that time.

At first thought, the plan of sending a signal, say from Arlington to Paris, "flashing it back" from Paris to Washington, and ascertaining the elapsed time, would come to mind as the simplest and most accurate. Unfortunately, however, there is no apparatus in existence which would perform this function for Hertzian waves as a mirror does for waves of light, nor has any apparatus been devised which would, immediately upon the reception of a signal, send back another signal. It becomes necessary, therefore, to use two independent signals, separated by an interval of some eight or ten seconds (sufficient for the manipulation of the proper switches) and to devise some means of accurately measuring this interval of time, as well as the time required in transmission. This is done as follows, Figs. 1 and 2 being graphical representations of the events which actually take place:

Let the two vertical lines, Fig. 1, represent corresponding times in Washington and Paris, the marks T_o and T_o, representing any instant at the two places. Suppose, then, a signal to be sent out from Arlington at an absolute time T_1, it would reach Paris at a time T_2, due to the time taken for transmission. Then, if a signal were sent from Paris at a time T_3, after an interval T_2-T_3 seconds, it would reach Washington at a time T_4. The interval of time T_1-T_4 would then be greater than the interval T_2-T_3 by twice the transmission time, and an accurate measurement of T_1-T_4 and T_2-T_3 would give the time required, T_1-T_2 or T_3-T_4.

In the actual work, Fig. 2, the two lines represent the two moving films of photographic paper in the registering machines, and T_1, T_2, T_3 and T_4 the marks made upon these paper strips by the radio signals. It remains, then, to convert the intervals T_1-T_4 and T_2-T_3 from linear distances on the paper bands to the time intervals which they represent, and in the method of making this conversion lies the secret of the high degree of accuracy which has been obtained.

Two tuning forks, whose periods are certain fixed lengths of time, are mounted in a manner to be described later, so that they make horizontal marks upon the moving sensitive bands of paper. The linear distance between any two lines then represents an interval of time equal to one half the period of the tuning fork, or about 0.01 second. If this period is made sufficiently short, the paper runs fast enough (a maximum speed is about 10 inches per second), and the marks are fine enough to give accurate reading with a measuring machine of the whole spaces and fractions of spaces, it is perfectly possible to measure the time interval corresponding to any two marks on the paper with a probable error of not more than one ten-thousandth of a second.

With such an accurate method at our disposal, however, we are dependent upon two conditions—that the machine shall be sufficiently sensitive to respond to and record the received currents, and that the marks made upon the paper shall be sufficiently fine to give accurate readings. Furthermore, it must give a continuous and permanent record of the received currents, in order that, when the observations are being reduced, the signals themselves may be separated from the marks caused by atmospheric disturbances and signals from interfering stations. As was mentioned above, the photographic registering galvanometer seems to offer the most satisfactory solution of the problem; for experiments conducted with it between Paris and Toulon, France, in 1913, and across the Atlantic during the past winter, were markedly successful. The galvanometer we are about to describe, with all its attendant mechanism, was designed by Prof. Henri Abraham, Professor of Physics of the Academy of Sciences, University of Paris, and was built by the well-known firm of J. Carpentier, Paris. It is, in the opinion of all who have witnessed its operation and studied the results of its work, one of the most perfect machines that has ever been designed for the purpose.

Unfortunately, no photographs of the apparatus have been taken, but one may understand, from Fig. 3, the construction of the galvanometer, the photographic registering apparatus, and the physical principles involved.

The galvanometer proper consists of a powerful electromagnet M whose magnetic circuit is practically closed, supplied with current sufficient to give a flux density between the pole pieces of about 20,000 gausses per square centimeter. This is not the maximum density obtainable with this magnet, but it is used because the coil seems to give better results with the slightly weaker field. The sensitive element is hung in a suspension frame S which is fitted to swing with a slight movement in the vertical plane, so that the pencil of light from the mirror may be brought to the required elevation at the lenses. Between the conical pole pieces P and P_1, which are carried by the suspension frame, swings the coil C_1, an elongated bobbin about ⅝ inch in length and $\frac{1}{16}$ inch in width, wound with the finest drawn wire to a resistance of 50 ohms. Just above the coil, on the short wire from which it is suspended, is cemented a very small section of a spherical concave mirror R, whose radius of curvature is equal to the distance from the coil to the focal point on the far side of the lens. The torsion elements, the upper one of which is carried in an adjustable torsion head T, are of rolled bronze, in the form of a very thin ribbon about 0.03 inch wide. The galvanometer is remarkably "dead beat," as may be seen from an inspection of recorded current impulses, A, Fig. 4. This record was made for the purpose of comparing the standard clock or directrice, whose tick is shown at D, with a number of other clocks and relays, one of the smaller ticks being shown at E, and another at "pendule relay." The sharp break at D gives an excellent mark with a deflection of about 0.3 inch, and the coil comes back to absolute rest in the short space of 0.035 second. In A, Fig. 5, is shown an Eiffel Tower signal received at Arlington, and in B is shown one of the time signals from the same station—four dots and a long dash. These signals are plainly visible, with a deflection of only 1 millimeter, yet they were recorded with a current in the coil of but one four-billionth part of an ampere.

The registering apparatus is similar to that of a moving-picture camera, consisting of nothing more nor less than a light-tight box for the spools of photographic paper. This is unwound and threaded around a train of wheels in such a manner as to pass by a small horizontal slit in the front of the box. This opening is situated at the focus of the lens system, with the result that any pencils or beams of light passing through the lens are recorded on the moving strip of sensitive paper. The lens system used is a high-grade type similar to those employed for photographic work in general. The lens, however, is ground cylindrical, with its axis in a horizontal plane, so that any two parallel pencils of light passing through in this horizontal plane remain parallel up to the focus, whereas two parallel pencils in a vertical plane, one above the other, are focused to a *point* in the vertical plane. A glimpse at the optical arrangement will show why such a combination will give the very fine lines that are so essential to accuracy.

Light from the arc lamps passes out the long tube A, through a set of condenser lenses and a horizontal slit in the end about 0.03 inch high, to the prism B, where it was reflected as a horizontal beam to the plane mirror C on the end of one prong of the tuning fork. Thence it is reflected through an adjustable horizontal slit D and again reflected by the mirror E, in a direction so as to pass through the lens. If this horizontal beam has an appreciable height when passing through the lens, although cut down as much as possible by the very narrow slit at D, it will be brought to the focus F as a horizontal beam of infinitely small vertical height. The cylindrical lens will then have performed the function not only of giving a very sharp horizontal line at the focus, but of retaining all the light of the beam and concentrating this light in the horizontal line. Now, if the tuning fork H be made to vibrate in a vertical plane, the horizontal beam which its mirror C reflects will pass up and down in front of the screen D, with the result that once every half-period the horizontal beam will pass through the very narrow slit in D and be reflected to the focus at F, so as to make the horizontal mark required. When the paper is in motion, these lines form the lines of Fig. 2, and are photographed as in Fig. 4 and Fig. 5 (A).

From the same arc lamp, light passes out of the short tube K, through another set of condenser lenses and an adjustable vertical slit (height about 0.25 inch and width about 0.01 inch) at L. This vertical beam is reflected by the mirror R on the coil, back to the focus F, where by the same property of the lens the light in the whole vertical height of the beam is concentrated in a point in the horizontal plane. We thus obtain on the photographic paper a pencil of light whose intensity is great, but whose vertical height, as of the horizontal beam, is infinitely small. Any currents passing through the coil C will cause the latter to deflect and to give a displacement of the pencil of light at the focus of the lens corresponding to twice the angle through which the coil has moved.

Here, then, is a machine which is able to make all the records we require; given a received antenna current sufficient to produce a readable deflection on the paper strip, it is possible to make the time measurements exactly, as outlined above. In Fig. 4 are shown three records made by this registering galvanometer in operation, which give a clear idea of the data used in reducing the actual observations. The middle strip B is a record of three Eiffel Tower signals received at Arlington on January 13, 1914. The points DDD mark the beginning of the dashes, each of which consists of about six sparks, whose actual deflection on the paper strip is about ⅝ inch. The lower strip, C, Fig. 4, shows a three-spark signal from the Eiffel Tower received at Toulon in July, 1913, and gives a very good idea of the clear definition of the current line and the lines made by the tuning fork. Strip A, already referred to, has to be taken with every set of observations. On it are inscribed the tuning fork lines and the ticks of the standard clock for one or two minutes. The intervals of the latter are known to within 0.00001 second, so that by measurement we find the interval corresponding to the space between any two consecutive lines.

The irregular marks on A, Fig. 5, are produced by atmospheric discharges, commonly known as "static" —the bugbear, not only of radio operators, but of anyone who wishes to read from a record the sparks of a received signal. When we know, then, the interval of time corresponding to the distance between any of the tuning fork lines, we proceed to take a set of observations and reduce them as follows:

At any predetermined instant, say 8:45 P. M., seventy-fifth meridian time, at Washington, and 1:45 A. M., Greenwich time at Paris, the two machines are started, the coils connected to the radio receiving sets, and the tuning forks set in vibration by means of the tripping latches. With the Arlington set at "sending" and the Paris set at "receiving," Arlington sends five dashes (T_1), which are recorded on the Arlington tape by means of current from a very small receiving set in the room, and on the Paris tape, some fraction of a second later (T_2), by current from the antenna and receiver. Paris immediately shifts to "sending" and Arlington to "receiving," and Paris sends five dashes, which are recorded on the Paris tape (T_3) by means of a small receiver in the room, and some fraction of a second later (T_4) on the Arlington tape by current from the antenna and receiver. If conditions have been favorable, we have now obtained a set of bands exactly as in Fig. 2, except that we have five sets of marks, of which we may take the mean for our determination. With the strips under a measuring machine, we find the average time (five readings) of T_1-T_4, and also of T_2-T_3, where T_2-T_3 will be about 10 seconds. Subtracting the two will give twice the transmission time.

It will be interesting to see what numerical results have been obtained and what conclusions may be drawn from these results. An average of some fifteen determinations, most of which were made in the week of January 12-17th, 1914, when very cold weather, accompanied by abnormally favorable conditions for radio transmission, prevailed over the whole North Atlantic, gave an elapsed time of 0.0213 second, with a corresponding speed over the 6,175 kilometers (3,837 miles) of 290,000 kilometers (180,200 miles) per second. According to Prof. Abraham, who personally conducted the above tests, this result may have a plus or minus error of about 3 or 4 per cent (about 6,000 miles per second), so that the exact result may vary from 180,200 miles per second to the mean value for visible light rays, 186,400 miles per second. It is certain, however, that the probable result is less than that of light by about 6,000 miles per second, a condition of affairs which brings out some very interesting facts. If we are to suppose that Hertzian waves and visible light waves are the same, as all known laws and phenomena go to prove, we have every reason to assume that their rate of propagation is equal. How, then, are we to reconcile the two—the assumption and the result? Very easily, by the assumption of a third condition—that the waves do not travel along the shortest route which we have calculated. Available evidence goes to show that the waves of night signals—and these tests were all conducted at night—do not travel along the surface of the earth from place to place, but are transmitted through the ether in the vicinity of an upper stratum of the atmosphere, at a height, say, of some eighteen or twenty miles.

It is very reasonable to suppose, therefore, that Hertzian waves radiated from an antenna may be projected upward at a small angle, totally reflected as for a beam of light at some plane between two strata of ether of different conductivity, and be deflected downward so as to reach the earth in the neighborhood of the receiving antenna.

The fact remains, nevertheless, that so little is known of the path of these waves, or the method of their transmission from place to place, that it is extremely difficult to predict the conditions which may have to be met and the efficiency which will be obtained in erecting new stations. We may, however, make further tests of this sort, over varying distances of land and water, over mountains and river valleys, for day transmission and night transmission under all atmospheric conditions, and, with our more accurate knowledge, obtain control of a situation which we now take for granted.

Instruments Used on Aeroplanes

Comments on Their Functions and Defects

The various instruments in use on aeroplanes would puzzle those who are not familiar with the work. Nominally, they are ordinary enough, but they must possess in many cases peculiarities of considerable importance. The list includes: (1) engine-speed indicator; (2) air-speed indicator; (3) horizontal (transverse) level indicator; (4) gasoline gage; (5) aneroid graduated in feet height; (6) oil gage; and (7) aeroplane compass. In addition to these are the bomb sight, the bomb release mechanism on some aeroplanes, and in some the wireless equipment, none of which is it timely to discuss just now.

ENGINE REVOLUTION INDICATOR.

The engine-speed indicator being the rough gage by which it is ascertained that the engine is pulling properly—since it is coupled to the approximately constant load of the airscrew—must not only, like all aircraft instruments, be exceedingly light, but must possess an accuracy very much in excess of that of the more ordinary motorcar speed indicator. For example, a 3 per cent error arising without warning would be a grave matter. If an engine intended to run at 1,150 revolutions per minute were in fact to be running only at 1,120 revolutions per minute, when the speed indicator declared 1,150, this would induce the attendants to suppose that the propeller was getting distorted and giving insufficient thrust. The result would be the delaying process of changing propellers. Now, the mere moving about of the flexible driving shaft will often be found to make 3 per cent difference in roughly constructed speed indicators. Another fault which is found is that of giving a speed reading when speed is rising different from that given when it is falling. This lag may in the extreme case endanger a pilot, apart from leading, as in the previous case, to unnecessary waste of time owing to misleading information about the state of the engine.

It is not always recognized that when the instrument is exposed to the vibrations of an aeroplane the readings are often different from those obtained in steady test. The test should, therefore, be made in such a way that moderate vibration can be applied. On a motorcar a continual swing of the needle from, say, 23 to 26 miles per hour would be no grave defect, but in the air such a swing covers the percentage range of variation which is tolerable and therefore the reading is certainly not dead-beat enough.

The problem is a difficult one, partly because of the high engine speed used, in many cases up to 1,800 and 2,000 revolutions per minute—a very widely different matter from the road wheel speeds of cars—and partly because of the much greater importance attachable to the result; its solution, however, has been remarkably well obtained in this country by Messrs. Elliott Brothers, Messrs. Smith & Sons, and others.

AIR-SPEED AND LEVEL INDICATORS.

The air-speed indicator has been dealt with at various times in these columns, and the controversy between the gravity control and spring control of the pressure gage has been reduced to its elements in many paper discussions.

The level indicator is not always carried, and when carried is not always transverse as it should be. It is usually a small arched spirit level. The objection to carrying such a level fore and aft is that the readings are rendered even more fictitious and misleading in this position by the acceleration of the aeroplane. When the machine is flying dead level a fore-and-aft instrument will indicate a substantial gradient if the aeroplane be accelerated or retarded. In this position, therefore, it should be abandoned. When it is placed transversely there are errors due to side gusts, but these are very much smaller and cannot lead to that great bugbear of the flyer, "stalling" the machine.

The purpose of the transverse spirit level is in part fulfilled by Mr. Ogilvie's floating "bit of string" hung clear of the intake or slip stream of the tractor airscrew, because any continuous banking without turning involves yawing, and therefore a side wind strikes the string. Were the string easily set clear of propeller disturbances and its indications more easily visible within the pilot's inclosure, especially at dusk, its universal use would be assured. It scarcely seems necessary to mention that the transverse spirit level shows "level" however steeply the aeroplane be banked, provided the bank is the dynamically correct one for the radius and speed of the turn.

GASOLINE GAGES.

The gasoline gages for both level and pressure are by no means to be overlooked among the important, and indeed essential, instruments on an aeroplane. Moreover, their installation offers several difficulties so considerable that they are but imperfectly met.

The volume of gasoline is so large nowadays that the use of a gravity flow as sole supply is practically out of the question (in view of the respective levels of carbureter and fuselage). The pressure feed tanks are often under the seat of the passenger, and as a loss of pressure must not result in a forced landing without plenty of warning, it is becoming universal to use a gravity supply of fuel from an auxiliary tank placed high up and containing one hour's supply or more. This tank is kept always full by permanent pressure on the main tanks. The pilot wants to know this pressure, and a gage for this is fitted. He wants to be certain that he is not over-pumping, else he merely forces gasoline to waste through the overflow from the top or gravity tank. The gravity tank must have access to the open air by this overflow pipe, otherwise fuel will not be supplied under gravity on just the very emergency arising from loss of tank pressure. The fuel overflow from the upper or gravity tank might be made to advertise itself but for the fact that it will blow back into the face of the pilot and temporarily blind him. This means a fuel level gage in the upper tank.

All gage glasses, reflex and others, are hard to read from the distances usual in practice owing to the white color of the liquid, the poor light at dusk, and other reasons. All dial gages at present made involve complications, and are not usually fitted with mechanism for transmitting the information to the pilot cab. The main tank level gage being under pressure is subject to the same difficulties. There are pneumatic transmission devices, which mostly suffer from grave errors due to the expansion of the inclosed air with temperature or with the very large and rapid changes of altitude of an aeroplane. Moreover, all pipe-work on aeroplanes has been proved difficult to maintain intact in view of vibration and distortion of the machine generally both in the air and by the shock of landing.

These remarks indicate roughly the problem for those who care to make an attempt to solve it thoroughly and simply. The essential necessity for giving full information unaffected by the banking, diving, rolling, or acceleration of the aeroplane is apparent when it is realized that unexpected shortage of fuel means a forced landing, perhaps over enemy lines, perhaps over bad territory at home.

THE ANEROID.

The aneroid is one of the instruments which has been perfected to a very remarkable degree by the advent of flying. Three years ago there existed no aneroid which did not suffer from the serious defect of a violently vibrating index needle, or alternatively of substantial inaccuracy from friction or damping under which the vibrations were masked. Much labor has been expended in getting the support of moving parts situated at the precise center of gravity of these parts—an alteration which was never needed till an aneroid was required for accurate reading on a vibrating support. The balancing of those portions of the expanding boxes which may be regarded as moving parts is not entirely an easy task, but the solution exists. What does not exist is any means by which the flyer can tell whether the reading of the barometer has changed owing to atmospheric variations during the four or five hours since he left earth. Any error that arises in this way the flyer reads off, unwittingly thinking himself to be higher up or lower down than his real altitude. Here again the physicist may yet come to the rescue, so the problem is posed for his attack.

OIL GAGE.

Even so small a matter as the oil gage on the engine's oil circulation requires special care with some aeroplane engines. Thus, if the oil pressure is too high the engine uses an excess of oil and thus reduces the number of hours of air endurance; that is, it may involve a forced landing earlier than expected. Other engines are inclined to cause an excessive pressure at the time of starting, when the oil is cold and highly viscous. The pressure rises so high that the gage either bursts, or, if it is strong enough to take the high pressure, is insufficiently sensitive to read at the low pressure of normal use with warmed oil.

THE COMPASS.

The aeroplane compass must, after being installed, be swung so as to eliminate by small adjusting magnets the error due to permanent magnetism of steel parts, just as a ship's compass is swung. It must be corrected, if possible, to avoid quadrantal error from the effects of soft iron parts, such as tanks, which may be near by. It must, far more particularly than a ship's compass, be corrected for the effects of vibration, which cause a very large deviation. It must also be capable of allowing a course to be steered direct north, and no swing should be caused by banking. These corrections will be seen to be substantially different from those required on board ship, and substantially more searching.

LIGHTING.

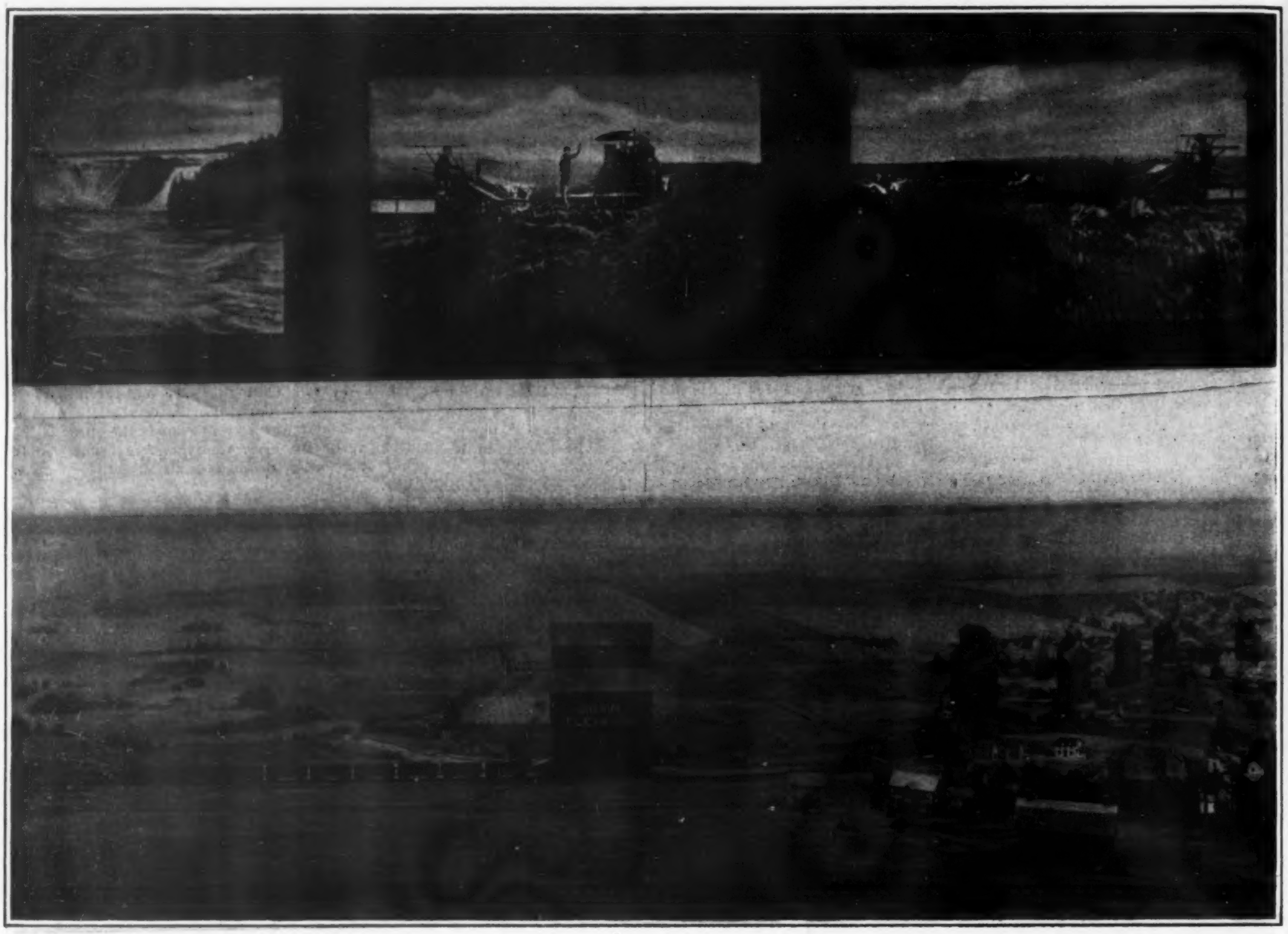
Lastly, the illumination of all instruments on aircraft is a peculiar problem. Luminous paint of all kinds is useless, because, however valuable this might be after dark has set in, no luminous paint has sufficient value to act adequately during the twilight, and it is precisely in twilight and not in the dark that the illumination is required. Electric lighting must be very carefully moderated to a minute light, else the contrast between a well-lighted instrument board and the poor light outside blinds the flyer, who therefore cannot safely alight or properly distinguish his objective.—*London Times.*

Experimenting With Searchlights

Taking a lesson from the European war, the Secretary of War has directed the Engineer Corps to make an exhaustive study of and extensive experiments with the use of searchlights, flares, star bombs, and other lights by the troops in the field. For some time fortifications and the Navy have been using searchlights, and in the Russo-Japanese war they were employed by both armies, but not until the European conflict did they become such important auxiliaries of an army. Searchlights and star bombs have become absolutely necessary to meet the constant night attacks by armies in both theaters of war. Searchlights are not only used to detect the movements of the enemy, but to blind troops when they are charging across the zone of fire, and to discomfort the pilots of aeroplanes flying aloft. The type used in Europe and that one that will probably be adopted in this country will throw an intense light for a mile. On a body of troops charging across a clear field in the European war hundreds of searchlights are immediately concentrated. Frequently whole brigades are thrown into greater confusion by the blinding lights from the defending force than if they were subjected to field artillery fire. It is impossible to advance a body of troops in the face of strong searchlights.

Searchlights, as far as can be learned from unofficial reports, are only used after the fire of field artillery ceases and at a time when the enemy is charging. They are kept dark during the field artillery duel which usually precedes an engagement. To turn on a searchlight previous to this time gives the enemy an opportunity to use its field artillery effectively. In illuminating a field over which the enemy is to advance star bombs and flares are employed. Flares have been developed from fireworks and are similar to what is known as red, white and blue lights used in Fourth of July celebrations in illuminating streets and parks. Sappers are sent out a distance before the line with flares which are connected with the headquarters of the officers in command of the first line and can be set off at intervals so as to keep the battle front illuminated throughout the night. Star bombs are also a development of modern fireworks. They are shot from mortars up into the sky, where they will maintain an intense light which illuminates the surrounding country for twenty minutes. Before one bomb dies out another is shot up in the air, and thus the battle front is kept as well lighted as the streets of any city. There is also a type of star bomb which is shot up into the sky like an ordinary rocket. Some of this type are used in signaling at night by both armies.

The Washington Engineer Barracks, where the experiments are being conducted, has taken on the appearance of a fireworks factory. Not only is the Engineer Corps experimenting with every type of light producer that it has been able to obtain from foreign countries, but it is testing out quite a number of American inventions. This work will continue at Washington Barracks until some time in October, when all of the searchlights and light producing devices will be shipped to Texas, where a battalion of Engineers will try them out in the field. It is not proposed by the Secretary of War to purchase a large quantity of searchlights and fireworks, but according to his instructions the officers will develop a type of searchlight and light producing devices that can be produced by small changes in standard articles of this character that can be purchased in the open market. In the event of war the country would depend largely upon private concerns to furnish this class of equipment for the Army.—*Army and Navy Journal.*



Where wheat is king. Panorama of Canadian grain district, with trains running to and from grain elevator. Upper illustrations show detail scenes in the grain country.

Scenic representation of a typical Canadian forest, showing wild game. Live beaver in the foreground heightens the illusion.

CANADA AT THE PANAMA-PACIFIC EXPOSITION

Vancouver harbor. One of the most striking panoramas shown in the Canadian Pavilion. This scene shows the city as it will appear in the future, after improvements have been carried out.

A Nation in Perspective

(*Continued from page 17.*)

the real and the painted portions of this panorama comes through a barrel of apples. The genuine apples are piled in tumbling richness against the canvas on which is painted the barrel from which they are being poured. But it takes a keen eye to notice where the real apples end and where the painted begin.

The east court is devoted to a magnificent panorama of timber, big game, fisheries and livestock, with a beaver dam where live beavers sport by way of still further heightening the effect. Only a portion of this panorama is shown in the photograph.

Photographs, of course, are here in great number and infinite variety, and potted flora. Many cabinets of exhibits amplify the lessons taught by the major panoramas. But the lessons the panoramas teach are the principal lessons: of a rich, virile, buoyant country, fortified by natural resources that apparently are inexhaustible, and that certainly promise to America's great northern neighbor a future as golden as the grain that chokes her warehouses.

Canada has for years been an extensive and persistent advertiser, and the grand building and the elaborate and costly display at the Exposition are unmistakable evidences of the value it places on publicity and the satisfactory results it has obtained.

Graphite

Most persons are aware that lead pencils are not made of lead, but that the so-called black lead in them is a full brother to coal and to the aristocratic diamond, and that it is identical with many other substances in common use, such as the blacking on the kitchen range, are additional facts not nearly so well known. A recently installed exhibit in the National Museum's Division of Mineral Technology, at Washington, shows the various forms of graphite, including natural and manufactured, as well as the various ingredients used in this industry.

Black lead and plumbago are popular terms for a form of pure carbon whose proper name, Graphite—from the Greek word meaning to write—is more accurate and more appropriate. As a mineral from the earth, it has been known and used since about the middle of the sixteenth century; but for a matter of two hundred years thereafter the conceptions of science with reference to its true nature seem to have been vague. Meanwhile, in lieu of any regular name, various nicknames were assigned, originating in superficial resemblances to better known substances. Two of these nicknames, black lead and plumbago, outgrowths of the fact that lead is soft and when tarnished will leave a black streak on paper, have persisted.

Graphite occurs rather frequently in granite rock throughout the Appalachian system from Maine to Texas, and has been mined in various localities, notably at Ticonderoga in New York, and at a number of points in Pennsylvania and New Jersey. But the Appalachian range of occurrences, and with them those of Canada, consist of disseminated grains known to the trade as flake graphite, and the cost of recovery has pretty generally proven prohibitive. For a number of years the chief supply of natural graphite has come from Ceylon, where the mineral occurs as massive veins. Another prominent graphite field lies in the Tunkinsk Mountains of Siberia, and Mexico also has a rather important source in Sonora. In this country, Montana has the only occurrence, other than of flake graphite, thus far encountered.

Few people begin to realize the range of uses to which graphite is put, for it is an essential though minor ingredient in a great number of unsuspected connections as common as that of lead pencils. With many of these the graphite man is himself unfamiliar, beyond the simple fact that this or that manufacturer purchases from him; for in such uses it is apt to represent part of a secret process. Lead pencils, lubricants, electrical conductors, and black polishes and paints are prominent conventional uses, but it is liable to be present pretty much anywhere that anti-friction, unfading blackness, heat resistance, electrical conductivity or non-corrosiveness are desirable properties, and the fact that without graphite the derby hat as we know it could not be, is an example of its importance as an incidental ingredient.

A few years ago, while Dr. E. G. Acheson was engaged in conducting a high temperature experiment in which he was using anthracite coal in an electrical furnace at Niagara Falls, he happened to let his furnace run beyond the intended temperature, and upon examination found that in place of the anthracite coal put in, the carbon removed was in the form of graphite. In view of the importance of graphite to man, Dr. Acheson's discovery was a valuable one. While commonly referred to as "artificial graphite," the product from the electric furnace is artificial only in the sense that manufactured ice is artificial. It is not merely an artificially prepared substitute, but is graphite.

An exhibit recently installed in the National Museum visualizes the manufacturing procedure involved in the making of graphite in accordance with Dr. Acheson's discovery. It shows the raw materials—anthracite coal, coke, or other form of carbon—a model reproduction of the furnace in operation, the product as it comes from the furnace, and the general range of preparations.

The Manufacture of Condensed Milk, Casein, Etc.—II*

Discussion of Methods of Analysis

By R. T. Mohan, B.A.Sc.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2061, Page 15, July 3, 1915

IN MOST factories it is customary to make a trial sterilization on a small batch to see what temperature the milk will stand before it curdles. To do this a small sterilizer is built on the same plan as the large one and holding half a dozen cans. The milk is sterilized at 235 deg. to 240 deg. Fahr. (113 deg. to 116 deg. Cent.) for about thirty minutes. The milk is next shaken to make it smooth and uniform. About four dozen cans are fitted into crates and placed in a machine which has a very rapid oscillating motion for one to three minutes, depending on the milk. After shaking, the milk is stored in a warm place (practically a large incubator) for about three weeks prior to shipping. Any "leaks" or "swells" are then picked out, and the good cans are labeled, cased, and shipped.

This, therefore, is a product which is desirable from every standpoint, handled under sanitary conditions, and completely sterilized. It is a concentrated whole milk product containing no adulterants, and finds a ready use for general and for infant feeding.

Absolute cleanliness is maintained in the factories. All pipes are cleansed daily with hot soda solution and then with live steam, and the vats, coolers, and vacuum pans are scalded, scrubbed, and sand-papered every day.

Defects.—Swells, flat sours, and sweet curdling in evaporated milk are due to under-sterilization. Curdiness (other than sour curd) is due to precipitation of the curd as a hard mass under the action of the heat on a product of high solids and acidity. The hard grains sometimes found in the bottom of the cans consist of mineral matter, mostly calcium phosphate, precipitated owing to over-concentration.

Plain condensed milk is milk evaporated about 4:1, which is filled into barrels, and used within a day or so by ice cream manufacturers and confectioners.

ANALYSIS OF CONDENSED MILK.

Sampling.—In the evaporated or unsweetened variety there is little difficulty in getting a uniform sample from the can, as it is only necessary to stir it thoroughly. However, the condensed or sweetened variety presents a possibility of error, especially when the sugar has settled. The best method of sampling in this case is to transfer the whole contents of the can to a large mortar and thoroughly grind and mix it; a 40 per cent solution is then prepared and analyzed.

Solids.—For the sweetened condensed milk a quantity of the 40 per cent solution is evaporated to dryness, *in vacuo*, or in a McGill oven (in which the product is dried in a current of air at 70 deg. Cent.). Drying to a constant weight on a steam bath or in an ordinary air oven does not insure accurate results, as the solids seem to retain a small proportion of the moisture with great tenacity, and if dried too long undergo chemical changes.

For the unsweetened or evaporated milk two methods are available, one by taking the specific gravity of the 40 per cent solution and calculating the solids by formula, the other by evaporation and weighing. For taking the gravity hydrometers with special scales, called lactometers, are used. The two most common are the New York Board of Health and the Quevenne lactometers. In Canada the former is used almost entirely. The formula used to calculate the solids is:

$S = 1.2F + 0.25\ (G - 1{,}000) + 0.14$, where S is the percentage of solids, F the fat, and G the specific gravity referred to water as 1,000.

This gives good results, but only providing the fat has been determined accurately. It is obvious, therefore, that this method cannot be relied on entirely, and a quantity of the milk must be dried *in vacuo* and the residue weighed.

Ash is determined by burning the residue after evaporating the milk for solids. A temperature sufficiently high to votalize the chlorides must be avoided.

Protein is determined by the usual Kjeldahl method. The conversion factor is somewhere between 6.25 and 7.04. Provisionally the factor 6.38 is used.

Sugar.—In evaporated milk the only sugar present is lactose, and this is determined either by the polarimeter or by the gravimetric Fehling process.

In the condensed milk there is, in addition to the lactose, a large percentage of cane sugar, and accurate results are difficult, co-operative work by the U. S. Association of Agricultural Chemists on the same samples having shown results for lactose varying from 9.74 per cent to 12.05 per cent, and for cane sugar from 43.06 per cent to 46.74 per cent.

The author has had a batch of milk prepared specially, and from the weight before and after concentration calculated what the composition of the finished product should be; invariably analysis showed a little more lactose and a litte less cane sugar than there should be. It was thought possible that in the concentration there was a slight inversion of the cane sugar, making it appear to be lactose, but from experiments on mixtures of cane sugar and lactose under similar conditions, it is certain that no change takes place.

Fat.—The determination of fat is by far the most important of all, and it is most difficult to get accurate and concordant results.

Table 4 shows some results obtained by different methods. These results only deal with evaporated milk, as the condensed milk requires different treatment.

TABLE 4.

Determinations in Fat by Different Methods.

Calculated fat.	Babcock.	Ether extraction.	Rose-Gottlieb.
%	%	%	%
7·25	6·9	6·63	6·87
7·98	7·7	7·46	7·78
8·74	8·1	8·13	8·28
9·14	8·7	8·33	8·90
9·70	9·1	8·67	9·40
10·35	10·3	9·13	10·07
Average 8·86	8·46	8·09	8·55

The most reliable of these methods is the Rose-Gottlieb, but this averages 0.31 per cent fat low. The reason for these differences lies in the physical change which the milk has undergone during the concentration, homogenizing, and the sterilization. The casein has been invisibly precipitated into an insoluble curd, and each very minute particle of precipitated casein incloses a small amount of fat. In order, therefore, to extract all the fat it is necessary to dissolve completely the curd and liberate the fat. To this end many modifications and new methods have been proposed. With one or two exceptions these are not feasible.

In the ordinary Babcock method it is almost impossible to get a clear fat column; the acid appears to char the milk to a greater or less extent, depending on the concentration, season of the year, etc. The only rapid and accurate modification known to me is as follows: 4.5 grammes of the milk is accurately weighed into an ordinary Babcock test bottle, 17.5 cubic centimeters of water added, and thoroughly mixed. Then 17.5 cubic centimeters of concentrated sulphuric acid is added and mixed to dissolve the curd completely, and the mixture is centrifuged for five minutes. The bottles are filled to the neck with hot half-strength sulphuric acid, centrifuged again for two minutes, filled to the top of the graduations with boiling water, centrifuged for one minute, and the fat column read at 185 deg. Fahr. This reading multiplied by four gives the percentage of fat in the evaporated milk. The important points to be observed in this method to obtain a clear fat column and complete recovery of the fat, are correct dilution of the milk (4:1) before adding the strong acid, and the addition of hot half-strength acid in place of water after the first centrifuging.

TABLE 5.

Fat by modified methods.

Calculated fat.	Modified ether extraction.	Modified Babcock.
7·25	7·20	7·30
7·98	8·00	7·98
8·74	8·75	8·68
9·14	9·20	9·20
9·70	9·65	9·60
10·35	10·40	10·40
Average 8·86	8·86	8·86

In the gravimetric methods it is also necessary first to remove the caseous matter, and then extract the fat. This is best done by the following method. A weighed amount of the evaporated milk diluted 4:1 is absorbed on a filter coil free from fat, placed in an extraction cone, and without any preliminary drying extracted in a Soxhlet apparatus with 1 per cent acetic acid for two hours. This removes most of the protein matter. The cone is washed with hot water to remove the acetic acid, dried in an air oven at 100 deg. Cent. for six or eight hours, and extracted for eight hours with ether in the ordinary way, and the extract fat weighed.

The reliability of these modified methods is shown in Table 5.

In determining the fat in condensed milk there is an added difficulty of the presence of cane sugar. For gravimetric estimation the modified ether extraction method described above is to be recommended. For a rapid centrifugal method, the following modification (by Leach) gives fair results: 15 cubic centimeters of the 40 per cent solution of condensed milk is measured into a Babcock bottle, and enough of a copper sulphate solution is added to precipitate the proteins. The bottle is then centrifuged, and the precipitated proteins carry the fat to the bottom of the bottle. The clear liquid above is then drawn off by means of a pipette having a wisp of cotton wool over the end to prevent any of the precipitate being withdrawn, and the remaining fat and protein is thoroughly mixed with water and again centrifuged. This operation is repeated until the sugar has all been removed; 17.5 cubic centimeters of water is added to the precipitate, then 17.5 cubic centimeters of strong sulphuric acid, and the operation continued as in the ordinary Babcock test. This method eliminates the trouble due to charring of the sugar, but still has the defects connected with the Babcock test when used for evaporated milk.

Milk Powders.—In making these the difficulty has been to produce a powder which when mixed with water would produce a fluid similar to milk in appearance, flavor, and physical properties. Many methods have been tried and numerous patents granted, but, with one or two exceptions, there has been little success. The two most successful processes are by drying on steam-heated rolls, and by spraying the milk into a tower.

In the roller system, the milk is run on to steam-heated metal rolls, generally *in vacuo*. The dried powder is scraped off the rolls and ground. The resultant powder, while fairly good, is not as soluble as it should be.

The spraying system has been more successful. The milk is first reduced in a vacuum pan to about one fifth of its volume. It is then atomized into the top of a hot chamber, the moisture being removed while the fine particles of milk are falling to the floor. The dried product accumulates on the floor as a very dry flour and needs no grinding. The powders produced by these spraying systems are excellent, and find a ready use with bakers, confectioners, etc. For composition see Table 1.

These products are analyzed by making a solution the strength of ordinary milk and analyzing this. All the difficulties mentioned for the analysis of evaporated milk are also met with in this product.

Casein.—When the milk supply is too heavy to be handled by the evaporators, it is usual to skim the milk, ship the cream in to the cities, and prepare casein from the skim milk. The present uses of casein are numerous and increasing. They include paints, dressing for textiles, cements and mucilages, plastic masses, sizing for paper, food products and many others.

The casein content of ordinary cow's milk averages 3.2 per cent. It is easily precipitated by acids. Technically, it may be made by spontaneous souring of the milk, or more often by the addition of acids, as hydrochloric, sulphuric, or acetic acid; also by precipitation by rennet. Combinations of these methods are also used, the casein being sometimes dissolved in alkali and re-precipitated by another acid. Many patents cover the manufacture of this product, each one of which has its own special claims. The casein is washed and dried on trays, preferably in a vacuum drier. It is then ground.

Those specially interested in casein and its compounds are referred to Robert Scherer's book on "Casein: Its Preparation and Technical Utilization."

Not infrequently the whey (after the separation of the casein by rennet) is evaporated down and the lactose obtained.

* Paper read at the Toronto meeting 1914, and published in the *Journal* of the Society of Chemical Industry.

Modern Substitutes for Butter*

Wholesome Materials That Have Long Been Under Suspicion

UNTIL the last few years the word margarine was usually associated, in the mind of the British public, with poverty; but now, under the new name of "Nuts and milk," with which advertising enterprise has made us familiar, it is becoming freely used in the kitchen and is even found on the breakfast table in many households. On the continent, where the general standard of luxury is not so high as here, butter substitutes are used far more generally; and the demand for the raw materials from which they are made has increased to such an extent as to cause a noteworthy increase in their cost. In most cases the legislation affecting butter substitutes has been influenced by vested interests, so that, while only partially effective in preventing fraud, it has checked the development of the industry. Taking into account also the universal prejudice against margarine which prevailed formerly, it is very remarkable that the industry should have made such advances. It is of interest, therefore, to examine its development in some detail, more particularly from the scientific point of view; for it is desirable at the outset to emphasize that the margarine industry is essentially scientific in character, and that considerable technical skill is demanded in its manufacture.

The finished margarine must be satisfactory in taste, odor, and texture; this necessitates that the fats composing it shall be entirely free from fatty acids, and show no tendency to become rancid. Much depends on the texture of the fat, which the user expects to be the same as that of butter. The margarine maker so blends his raw materials that the mixture has the same melting point as butter, and he is able, further, to vary the melting point to suit the climate, an advantage which will be more fully appreciated in the future when margarine has found its way to tropical countries.

The present success of the margarine manufacturer is to a large extent due to the great variety of raw materials which are now available. In the early days of the industry soft beef fat was the sole basis obtainable; this was known as oleo oil or oleomargarine, and the conditions of its manufacture were not always above suspicion. This has now been entirely changed; the factories are models of cleanliness; they are officially inspected, and above all, animal fats have become of secondary importance to vegetable oils.

The process of manufacture is briefly as follows: The carefully purified oils are blended at a suitable temperature, churned and pulverized with new or separated milk in suitable machines, cooled, washed, salted if required, and worked in exactly the same way as butter. The product is a butter substitute, and has the same composition, viz., about 84 per cent of fat. Therefore, on the accepted standards, it has the same nutritive value.

A certain amount of butter-fat is usually contained in the mixture, but by law this is not allowed to exceed 10 per cent. In Germany, Austria, and Denmark the presence of 10 per cent of sesame oil is obligatory for the purpose of ear-marking the substitute. Sesame oil gives a color reaction with certain reagents, which enables its presence to be very readily detected; for the British palate this addition of sesame oil is unwelcome. In Belgium the addition of 0.2 per cent of potato starch, as well as of 5 per cent of sesame oil to margarine is obligatory. It may be remarked that the analytical discrimination between butter and margarine is a lengthy process, and that the detection of 10 or 15 per cent of added fat to butter is a matter of considerable difficulty. All fats are very much of the same composition, and with one or two exceptions they lack individual characteristics. The analyst depends, therefore, on small differences in physical characteristics, or on the proportion of fatty acids of low molecular weight, for their identification when in admixture.

It is an increasing practice in factories and for culinary operations in restaurants or in the kitchen to use the pure or blended fats themselves without churning them with milk. The advantages of this procedure are obvious, and it will be followed more generally by the housewife in the future. Thus in the United States, and in the poorer districts of our large towns, enormous quantities of refined cotton seed oil are sold for frying purposes, and the use of nut and blended butters containing 100 per cent of fat for the same purpose is largely on the increase among the upper classes.

With the exception of olive oil the edible vegetable oils require very special refining before their characteristic flavors or impurities can be removed; in consequence it is only since these difficulties have been overcome in practice that they have been so largely used for margarine. It is certain that as the knowledge of refining processes increases, the development of the industry will be still greater. The methods of refining vary according to the oil; they are mostly jealously guarded as valuable secrets.

In Britain, and particularly in the United States, very large quantities of cotton seed oil are used either in margarine or for culinary purposes, both as a substitute for olive oil and as a cooking fat. About three-fourths of the world's production comes from the United States, about half of this oil being refined for edible purposes. The crude oil obtained by pressing the seed is first treated with caustic soda, then with fuller's earth, and finally made as nearly as possible free from taste and odor. From the point of view of the margarine maker, cotton seed oil is too liquid to be used in any large proportion, though its relatively low cost makes it a very desirable ingredient.

Far more important as butter substitutes are the nut oils—coco-nut, and palm kernel. The former is obtained by pressing copra—the flesh of the coco-nut, which is exported in a dried condition from its place of origin. In the past the copra-pressing industry has been localized at Marseilles, though in later years an almost equal quantity of material has been dealt with at Hamburg.

Palm kernels are the seeds of the palm fruit, of which the fleshy part is utilized for the manufacture of palm oil. The natives on the west coast of Africa collect the kernels, crack and remove the shell before the nuts are exported to Europe. It is stated that kernels were first brought to Marseilles as ships' ballast and thrown into the sea on arrival until their value was recognized. Originally the chief receiving port was Marseilles, but latterly the industry has been almost entirely carried on at Hamburg, where in 1911 93 per cent of the total quantity was dealt with, the remainder going to Liverpool.

The palm kernel oil made in North Europe last year is estimated at 125,000 tons, of which about 40,000 was refined for edible purposes. The kernels contain about 50 per cent of oil, which is extracted by pressing in hydraulic presses similar to those used for copra. The residue, palm kernel cake or meal, has found a very wide use in Germany as an ingredient of compound cake for cattle feeding, and in this form has been largely exported to England. The commercial success of the pressing industry largely depends on the price obtained for this meal, and no pains have been spared on the Continent to demonstrate its value to the farmers by means of scientifically conducted feeding trials. There is at present much talk of developing the industry in Britain, in which case the disposal of the cake here will be an important consideration. It is of interest that the decline of the industry in Marseilles is largely due to the cake failing to find a ready sale as cattle food in the south of France. If the new industry is to succeed here it will have to be supported by the agricultural interests.

Some idea of the magnitude of the nut-oil industry is gained from the following figures: The world's production of coco-nut and copra oil 1913-1914 is estimated at 377,000 tons, of which 300,000 tons were used in Europe. The total supply of hard vegetable fats (coco-nut and palm kernel oil) available for margarine is said to have been 240,000 tons in 1913, and perhaps 300,000 tons in 1914. Out of 347,000 tons of hard fat stated to be used for margarine in 1913, 204,000 tons were vegetable, and the quantity of vegetable fat used in 1914 may have amounted to 300,000 tons, i. e., the total visible supply. There is little wonder that there has been a great increase in the price of these oils, and that the tropical sources of palm tree oils are being widely exploited. Nearly all tropical countries report an increase in the area under coco-nuts, or an improvement in the methods of dealing with the existing trees, and in the machinery for making copra or extracting the oil, which is still very primitive and inadequate.

The nut oils resemble butter and differ from all other fats in containing a large proportion of fatty acids of low molecular weight. Butter contains acids from butyric acid upwards in the homologous acetic acid series; the chief constitutent of nut oils is lauric acid. Few of the remaining oils of commerce contain acids lower in the series than palmitic acid.

In preparing vegetable fats for the markets the all-important consideration is the careful selection of the raw materials. The oil is worked as fresh as possible, so that the best results are obtained when the seed is pressed in this country. It should be understood that the refining process involves no treatment with chemicals except the agitation with weak alkali to remove the fatty acids present.

The importance of fats in the dietary requires no emphasis; on the other hand, it is questionable whether all fats have the same value as food materials. Fats, being glycerides, are decomposed in their passage through the alimentary system into glycerol and fatty acids. The decomposition is effected through the agency of an enzyme, lipase, so that the digestibility of the fat depends on the rate at which it is attacked by the enzyme. The fat has to be brought into a suitable state of emulsification before the enzyme can act on it; and though the factors controlling this state are still somewhat obscure, it is above all important that the fat should melt readily at the temperature of the body. Hence the comparative digestibility of a fat is in the first place based on its melting-point. Stearine is badly digested, liquid oleine is readily digested. The addition of sufficient oleine to stearine so as to reduce the melting-point of the mixture renders the stearine also digestible. Consequently the all-important point which margarine makers keep in view is the melting-point of their product in relation to the body temperature; if this is correct the material may contain some ingredients of a considerably higher melting-point.

It is of interest to note in this connection that vegetable fats are composed to a great extent of mixed triglycerides—that is, the glyceride contains more than one fatty acid in its molecule, whereas, normally one molecule of glycerol is coupled with three molecules of the same fatty acid. Experience teaches that the melting-point of the fat will be greatest when these are all the same. The melting-point of the fat is further influenced by the fact that it consists of a number of different glycerides, both simple and mixed. Since mixing of fats has the result of altering the relative proportions of these it is evident that the final melting-point of a mixture cannot be predicted on theoretical grounds, and it is agreed that butter substitutes of suitable melting-point are as digestible as butter.

It is customary to measure approximately the nutritive function of a food by its energy value in calories per pound, but modern research has shown this method to be inaccurate in two respects. In the first place it ignores the quality of the food; secondly, it neglects the presence in traces of the vitamines.

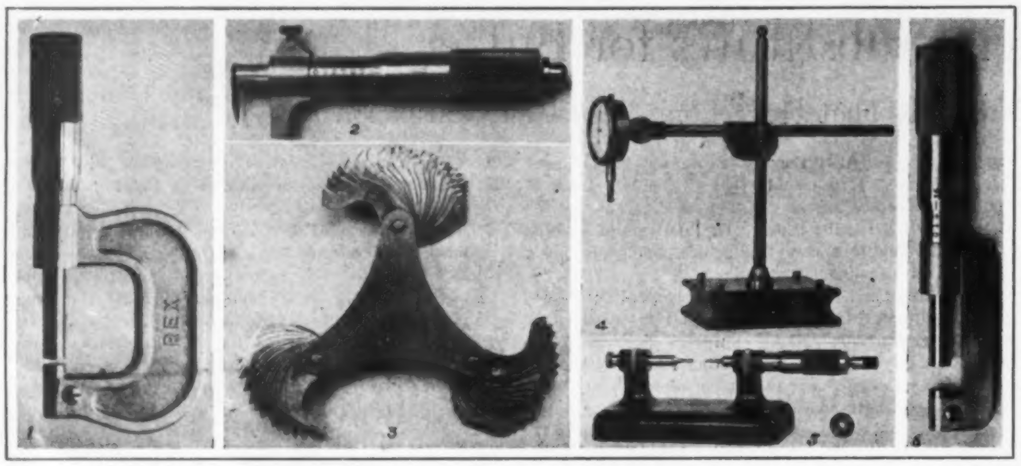
It has been found by experimenting with isolated food substances that diets otherwise sufficient in energy value fail to maintain growth and health, unless they contain certain substances hitherto unrecognized, but which have been named vitamines. The work in this field is of recent date, and is vitiated by the usual errors accompanying premature publication—indeed, much of it has been recalled already, but it would appear that the vitamines are of lipoid nature. They are present in butter, but not in the refined fats which are used for butter substitutes. How far this difference is of importance it is difficult to say; probably sufficient vitamines are present in the rest of the dietary to enable them to be dispensed with in the fat.

The question of quality is of more importance, though it has hitherto largely escaped attention. The individual fatty acids probably differ in their value in somewhat the same way as the different amino-acid constituents of the proteins have been shown to do, though to a less extent. The lower fatty acids in butter are perhaps specially important in making it of more value than olive oil, which is composed mainly of oleic acid, or than fats composed entirely of palmitic and stearic acids. Nut oils, however, resemble butter in containing a proportion of the lower acids, and hence their use in butter substitutes is entirely rational from the point of view of nutritive value.

In the foregoing the nature and preparation of materials available for use as butter substitutes have been indicated and their food value discussed. When it is remembered that the new industry is under rigid scientific control and conducted with a cleanliness mostly unknown in the butter industry, and, moreover, that it has made edible fats available for the masses at half the price of butter, it must be proclaimed as yet another of the achievements of science in the service of man.

* From *Nature*.

To Detect Leaks in Pneumatic Tires.—A device recently invented consists of a small metal frame, divided into sections, and closed on the sides by wire gauze. One side is shaped to fit the tire, and light down is placed within the case. When held on a tire the slightest air leak is indicated by the movement of the down.



Some new fine tools that have been developed for the use of the machinist.

1—A 1-inch micrometer caliper with forged frame. 2—Micrometer for determining the depth of gear teeth. 3—Screw pitch gage for V threads of screws and nuts. 4—Dial test indicator. 5—Bench micrometer caliper. 6—Hub micrometer caliper for measuring the hub lengths of cutters, thickness of saws, etc.

Fine Measuring Tools for Machinists

Nowhere is the march of progress so distinctly evident as in the building of machinery, for in all directions accuracy has reached a stage that is not generally realized; indeed, this very accuracy in the mechanical arts is the one thing that has made progress possible in many other directions. Where but a few years ago an accuracy of one one-hundredth of an inch was considered amply sufficient, and constituting a very fine class of work, to-day our builders of fine machinery are working to limits measured in the thousandths, and this degree of accuracy prevails to a very much greater extent than is usually realized.

Of course, in machinery that is required to perform very accurate operations very close measurements might be expected; but other causes compelling surprisingly fine workmanship have arisen in recent years. Some of these are the high speeds at which modern machinery is run, and the necessity of making parts interchangeable. As a familiar example that will appeal to many the automobile engine may be cited. Here is a machine that is required to operate continuously, and reliably, at speeds ranging from 900 to 2,000 revolutions a minute, and the motorcycle engine often is speeded up to well over 3,000 revolutions. To make this possible every shaft and bearing must be not only most carefully formed, but must fit each other with the utmost accuracy, as, at such speeds, the slightest irregularity of form or fit would result in friction that would quickly ruin the parts.

And then again in regard to interchangeability: when a part of an automobile gives out another can be quickly obtained from the maker that will take its place without any special alteration or fitting; and this is a direct result of accuracy in workmanship. This is such an everyday matter that little is thought of it, but in reality it is a remarkable mechanical achievement to be able to produce thousands of parts so exactly alike as to be perfect duplicates. To make this more evident it is only necessary to call attention to the fact that the finer the work is, the smaller is variation permissible between any two similar parts, and if the standard calls for a measurement specified to thousandths of an inch, the permissible variation must be less than a quarter of a thousandth; and such exactness is by no means easy to maintain when allowance must continually be made for wear of the tools used in the various operations, and other incidents constantly present that may affect accuracy.

To secure such accuracy as is here considered, repeated measurements must be made with standard measuring instruments, and wherever a large number of similar parts are to be made it is customary to provide special gauging devices with which to check the various operations; but there are certain standard measuring instruments that are universally used not only in all machine shops, but also individually by all first-class workmen, and some of these are shown in the accompanying illustrations, for which we are indebted to the courtesy of *The Iron Age*.

The first instrument shown is the ordinary micrometer calliper, which will indicate measurements in the size shown from 0 to 1 inch with an accuracy of a very small fraction of a thousandth of an inch. The anvil at the lower end is fixed, while the hardened steel pin is moved up or down by a fine screw having a very accurately cut thread of known pitch. The measurement is indicated on two scales, one on the fixed shank and the other on the revolving hub, which show by how many turns of the screw the measuring space has been opened. The instrument shown is of an improved kind in which the graduations corresponding to even multiples of 25 are placed above the measuring line on the hub, and the odd ones below, thus facilitating the reading of the scale. Fig. 2 shows another instrument constructed on the same principle, and designed for measuring the depth of screw-threads; and Fig. 5 is a bench micrometer, for general work. Fig. 4 is an indicator, constructed on a different principle, for detecting irregularities of form; thus the pin projecting from the dial can be placed in contact with the rim of a wheel. As the wheel is revolved the dial will indicate any irregularity of form, or setting, either plus or minus, to a great degree of accuracy. The supports for the gauge are so arranged that the pin can be adjusted in any direction. Fig. 6 is the same as Fig. 1, but with a frame designed for special work. Fig. 3 shows an ingenious method of arranging a set of screw-pitch gauges, 51 different gauges folding into the triangular frame.

Gauges, or micrometers, of the above description are articles of regular manufacture and sale, but they, together with some others of a similar character, constitute standards by which a multitude of special measuring and indicating instruments are constructed in every large shop to facilitate the rapid production of duplicate parts; and it is really the little "mike," that every good mechanic carries constantly, that has made possible the wonderful accuracy of present day machine work.

Typhus Fever

Typhus fever, which has just appeared in some of the prisoners' camps in Germany and is rife in Serbia, has been one of the great epidemic diseases of the world. Hirsch remarked: "The history of typhus is written in those dark pages of the world's story which tell of the grievous visitations of mankind by war, famine, and misery of every kind."

The name is of no great antiquity, for it was applied to a malady or group of maladies first by Sauvages in 1759. Until then, from the time of Hippocrates downward, it had been employed to designate a confused state of intellect, with a tendency to stupor. It was, in fact, not until 1850 that typhus fever was finally differentiated from typhoid or enteric fever by the researches of Jenner. One of the older synonyms for the disease was *jail fever*, and in the sixteenth century, at the first three of the famous "Black Assizes," judges, sheriffs, and jurymen were stricken with it as the result of infection from prisoners brought for trial. Another name formerly given to it is *Morbus castrensis* or "military fever," on account of the ravages occasioned by it among soldiers and camp followers from the time of the Thirty Years' war and the English civil war down to the siege of Sebastopol. Owing to the character of the eruption, typhus fever has sometimes been termed "spotted fever" (to be distinguished from cerebro-spinal fever, also known as spotted fever), and the German name is *flecktyphus*, also *typhus exanthematicus*, to distinguish it from *typhus abdominalis*, typhoid or enteric fever. The French name is similarly *typhus exanthématique*. Brill's disease, met with in New York, and Tabadillo of Mexico, seem to be manifestations of it. Few countries have suffered more than Ireland, and the disease has lingered in the outer Hebrides, but of late years has been practically unknown in England, and is seen but rarely in Scotland.

The invasion of typhus is, in the majority of cases, like pneumonia, sudden and severe after an incubation period of about twelve days. On the fourth or fifth day the eruption appears, first measly in character, but appearing on the wrists, trunk and thighs, and afterward becoming hæmorrhagic. The patient then suffers from severe fever with its usual concomitants, passing into extreme prostration. The nervous system suffers severely, and there is great muscular restlessness and tremor, excitement and delirium. In favorable cases the attack ends comparatively suddenly about the fourteenth day.

There are, of course, considerable variations in the course of the disease in individual cases; it is always to be regarded as a serious affection, and the average death rate for all ages under favorable conditions is 15 to 19 per cent; no age is exempt. An attack of typhus affords marked protection, and second attacks are as rare as those of smallpox. No special treatment for it has yet been discovered.

The ætiology of the disease is still uncertain; no specific micro-organism has been discovered, but it is probably protozoan in nature.

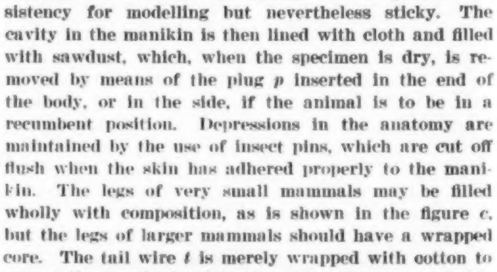
Typhus is markedly infectious, and in the infectivity is greater the larger the number of cases which are aggregated together. The mode of spread for a long time was uncertain, and until recently it was regarded as being conveyed by the emanations from the patient. A few years ago, in the epidemic which occurred in Aberdeen, Prof. Matthew Hay made the pregnant suggestion, on epidemiological grounds, that the disease might be conveyed by fleas. Further investigations have conclusively proved that it is conveyed by the body-louse, possibly by the head-louse also. This important fact explains how it is that typhus is so prone to appear in times of stress, war, and famine—when misery prevails and personal cleanliness is difficult or impossible to maintain.

Prevention of the spread of the disease largely resolves itself, therefore, into extermination of lice, and much attention is now being directed to the means which may attain this end.—*Nature.*

Built-In Hollow Method for Mounting Small Mammals

In the annual report of the Field Museum of Natural History is given a new method for mounting small mammals that is said to not only produce excellent results, but has a number of other advantages. This method was originated by Leon L. Pray, and is described as follows:

The initial step is to wire the specimen as though the ordinary method of mounting were to be followed. The inside of the skin is then given a coating of poison paste and immediately afterward the composition is put in and modeled. The most satisfactory composition used so far is one made of library paste, water, and a pinch of arsenic, to which is added whiting and sufficient chopped tow to make the mixture of the proper consistency for modelling but nevertheless sticky. The cavity in the manikin is then lined with cloth and filled with sawdust, which, when the specimen is dry, is removed by means of the plug *p* inserted in the end of the body, or in the side, if the animal is to be in a recumbent position. Depressions in the anatomy are maintained by the use of insect pins, which are cut off flush when the skin has adhered properly to the manikin. The legs of very small mammals may be filled wholly with composition, as is shown in the figure *c*, but the legs of larger mammals should have a wrapped core. The tail wire *t* is merely wrapped with cotton to secure the required thickness. The advantage of this hollow manikin method is that the mounted specimen is light, very durable, and almost indestructible.



Built in hollow manikin method for mounting small mammals.

Cartridge Cases for Field Gun Ammunition*

Ingenious Methods of Making the Powder Container for Rapid-Fire Guns

By Douglas T. Hamilton

The brass cartridge case that contains the powder charge for propelling the shrapnel shell from the bore of the quick-firing gun is drawn up from a blank of sheet brass. The number of operations necessary to complete the case depends on its size and the method of handling. Some shell manufacturers prefer to do more or less drawing at one operation, but in all cases the sequence of operations is practically the same. The material used for shrapnel cartridge cases generally consists of a composition of 2 parts copper and 1 part zinc. This alloy has been found to possess the best physical qualities, that is, high tensile strength and a large percentage of elongation when properly annealed. The drawing operations through which the cartridge case passes increase the hardness, and the ductility of the metal is restored by annealing. The annealing temperature in most cases is from 1150 to 1200 deg. Fahr. On reaching this temperature, the work is either cooled off in water or allowed to cool off gradually, as the speed of cooling does not affect its physical qualities. In the following, one method of handling the various operations will be described.

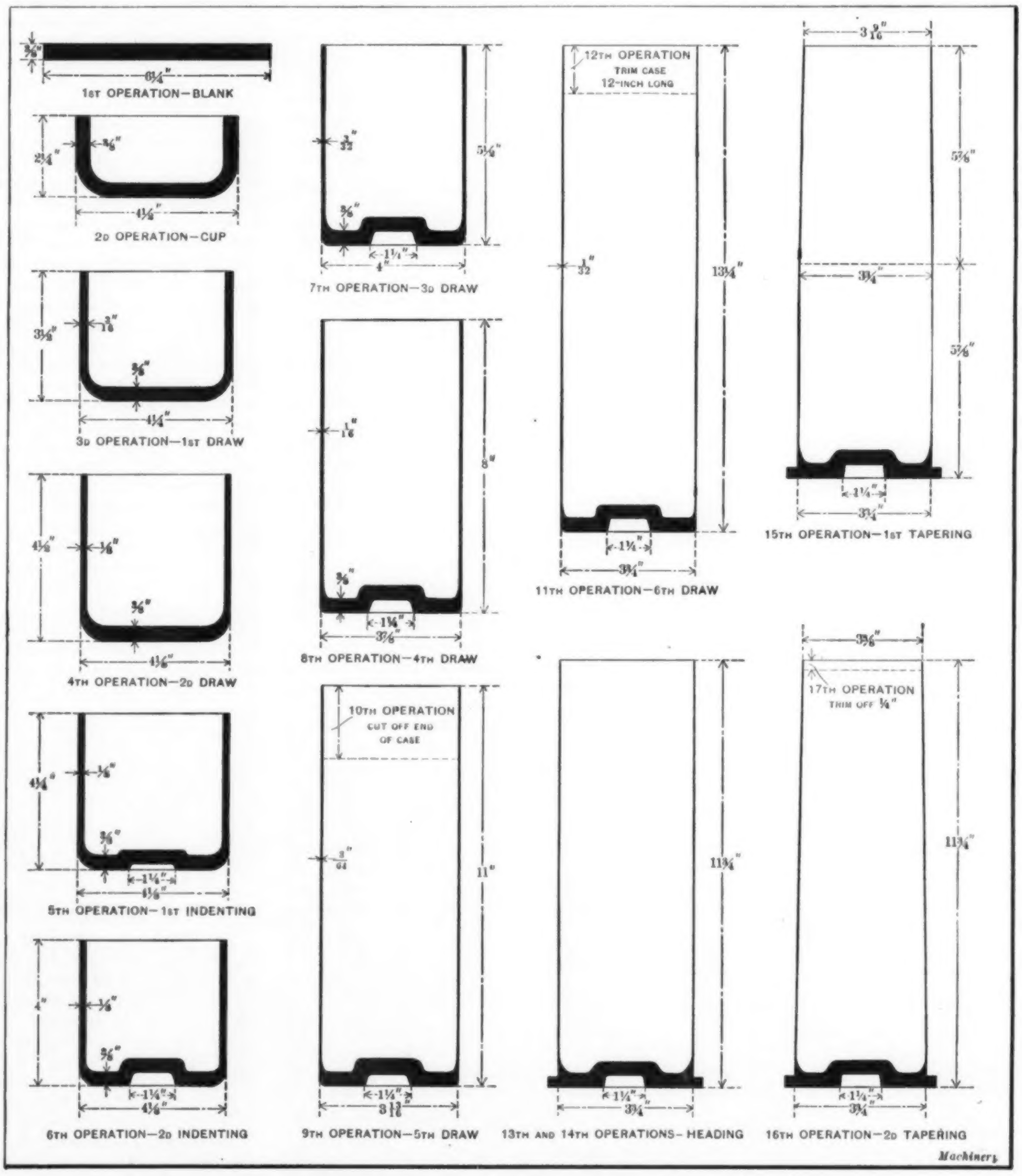
The illustration shows the sequence of operations—blanking, cupping, redrawing, indenting, trimming, heading and tapering—for making cartridge cases for 18-pound shrapnel. The first operation consists in cutting out a blank from 3/8-inch sheet brass 6 1/4 inches in diameter. The next operation is cupping. This is handled in a short-stroke geared straight-sided press. Before re-drawing, the cup is annealed, and the third operation, which is handled in a longer stroke press, is then performed. Annealing follows this operation, and then the fourth drawing or second redrawing operation is performed. This consists in reducing the fillets slightly at the corners, decreasing the diameter of the cup to 4 1/8 inches and increasing its length to 4 1/2 inches. The dimensions given here are approximate.

The fifth operation or first indenting operation, which consists in indenting the bottom, is handled in a press similar to that used for the cupping and re-drawing operations. This shortens the length of the case by 1/4 inch and forces the indentation about half way through the thickness of the stock. The second indenting is then accomplished. This again shortens the case by an additional 1/4 inch and squares up the corners. The case, without annealing, is now passed through the third re-drawing or seventh operation, reducing its diameter to 4 inches and increasing it length to 5 1/2 inches. It is annealed after this operation, and is then drawn out to 8 inches long by 3 7/8 inches diameter and the wall decreased in thickness to 1-16 inch. The case is then annealed and passes through the fifth re-drawing operation. The machine used for handling the fourth, fifth and sixth re-draws is a long-stroke, straight-sided rack and pinion press. After the fifth re-draw or ninth operation, the case is trimmed and about two inches cut off the end. This leaves the case in better condition for handling in the operations which are to follow.

The sixth re-draw or eleventh operation is performed in a horizontal drawing press of the hydraulic type provided with automatic reversing valves. This operation increases the length of the case to 13 1/4 inches and reduces its diameter to 3 3/4 inches. After this operation, the case is annealed and then 1 1/4 inch is trimmed off the open end. The thirteenth and fourteenth operations consist in heading the case. These are practically of the same nature, and combine to form the head of the case as shown in the illustration. The heading operations each reduce the length of the case 1/4 inch, and are performed in a 1000-ton hydraulic heading press operated by a geared compound power pump and having a working pressure of 5600 pounds per square inch on the ram. After heading, the case is annealed and the fifteenth operation, which consists in tapering, is performed. The first tapering or fifteenth operation reduces the mouth of the case to 3 9-16 inches diameter and gradually tapers it for a distance of 5 7/8 inches—half the length. The case is then annealed, pickled and washed and a second tapering operation is performed. This reduces the mouth of the case to 3 3/8 inches and tapers it completely to the head. The case is not annealed after the last tapering operation, but 1/4 inch is trimmed off the end.

The cartridge case, after practically every re-drawing operation is annealed, being subjected to a temperature of about 1150 to 1200 deg. Fahr. and then allowed to cool off or dipped in water which, of course, forms a

*Courtesy of *Machinery*.



Sequence of operations in making the cartridge case for an 18-pound rapid-fire gun.

scale on the surface of the case. This must be removed before any subsequent operations can take place. Several different solutions are used for this purpose, but a common one is sulphuric acid diluted with water to a strength of 1 to 4. This pickling solution is held in lead-lined wooden troughs and the case is allowed to remain in the bath varying from 8 to 15 minutes, according to the strength of the solution. The cases are then washed in lead-lined wooden troughs through which a stream of water is circulated to remove all traces of the acid.

The hardness of a cartridge case must be up to a certain standard. When too soft, a permanent set will occur from the pressure of the firing charge and the case will stick in the breech of the gun. When the hardness is too high for a given composition of brass, it is too brittle and will split or the head may blow off. There is, therefore, a certain hardness which must be adhered to as closely as possible. Some manufacturers hold the standard to within 20 to 25 on the scleroscope and reject cases striking 15 as being too soft, and 30 to 35 as being too hard.

The final operations required for completing the shell, although simple, call for considerable accuracy, and consist in carefully truing up the head and cutting the socket for the insertion of the primer, which varies in character in different countries. The mouth of the shell is bored out accurately for several inches from the end, to provide a proper seating for the projectile to be used, and the rim smoothly rounded.

In closing, it should be stated that the methods and machines employed in shrapnel manufacture call for the best mechanical skill obtainable.

Making Shrapnel Bullets

THE most deadly and effective parts of a shrapnel are the lead bullets which are held in the shell. When the timing fuse explodes the powder in the base of the shell, the nose is blown off and the bullets are thrown out in a cone shape. The range covered by these bullets in the 18-pound shrapnel shell is about 250 square yards. The lead bullets, which in most shrapnel are ½ inch in diameter, are made from several different compositions, but consist chiefly of 87½ parts lead and 12½ parts antimony. The number of bullets carried in shrapnel shells of the different governments varies. There are 252 in the American 15-pound shell, and 235 or 236 in the British 15-pound shell. The bullets used by the U. S. government have six flattened sides, to facilitate packing, whereas those used by foreign governments are spherical.

There are several methods of making shrapnel bullets, two of which are in use at the present time. One is to cast the bullets in iron molds, which are split in the center, so that the bullet can be removed when cast. Another is to cut off slugs from lead wire and strike these between dies in a heading machine. The bullet heading machine takes the wire from a reel, cuts it off, forms it and trims off the resultant flash automatically. In making the American bullets, a second operation follows, consisting in flattening the sides. For the flattened bullets, one equipment unit consists of one hydraulic wire extruding press and fourteen heading machines capable of giving a production of 850 bullets per minute. For the spherical bullet, the unit equipment consists of one hydraulic extruding press and eight heading machines, giving a production of 950 bullets per minute.

The method of casting lead bullets is antiquated to a certain extent and another method somewhat similar to that described has taken its place. The first step is to produce the wire from which the bullets are eventually made. This is accomplished in two ways. The first is the hot metal process and consists in pouring the molten lead into a cylinder, from which it is extruded through a die by a plunger advanced into the cylinder. By this method, it is necessary to allow the metal to settle before the press can operate. An improvement over this is utilized in presses built by a hydraulic lead press manufacturer and consists in first casting ingots of the required diameter and length and then charging the press with these instead of pouring the molten lead into the press chamber. Two presses have been designed for this process. One has a capacity of 700 tons and is charged with ingots weighing 150 pounds, whereas the other has a 900-ton capacity and is charged with 200-pound ingots. The product from these two machines is 1800 pounds of lead wire from the small and 2500 pounds from the large press per hour. The wire as it is extruded from the die is wound on a reel carrying 2000 pounds of wire.

There are two principal types of swaging machines used for making these lead bullets from wire. One carries a single set of dies, whereas the other carries twelve sets of tools. Twelve reels of lead wire are arranged in tandem on stands behind the press, six reels in a row. The wire is conveyed from these reels to the dies by a feeding mechanism, being guided to the individual tools by a plate having twelve U-shaped impressions in its top edge. The wire now passes over a spring which serves to lift it up slightly at each stroke of the press. Tools provided with half-spherical depressions in their adjacent faces and are set so that they come within 1-64 inch of meeting. The dies are guided and controlled in action by a special mechanism, and the press in which they are carried operates at 70 revolutions per minute. This gives a rated production of 840 bullets per minute. Considerable scrap is formed in making lead bullets by this process—in fact the scrap is about 33 per cent of the reel of wire; also owing to the setting of the punches a slight fin is formed around the periphery of the bullet, which is removed in a subsequent operation.

After forming, the bullets are taken to a tumbling machine, where they are tumbled for one hour. No other material is put into the tumbling barrel, but the action of the bullets working on themselves satisfactorily removes all the fins. Both the swaging and tumbling operations must be carefully watched, because of the necessity of having the bullets a certain weight. The allowable variation on one pound of bullets is one dram, and there are forty-one bullets to the pound. Ten pounds of lead rod make 6½ pounds of bullets, and the scrap resulting from the swaging operation is remelted and used over again. After tumbling, the bullets are inspected and are then ready for use.—From *Machinery.*

The Mobilization of War Raw Materials in Germany

THE question of the adequacy of the supplies of raw materials for use in connection with the production of the numerous war requirements in Germany is of particular importance and interest in circles outside that country, especially in Great Britain and the allied countries, because the continuance of the contest by our enemies as well as by ourselves depends not only upon armies, but also upon the possession of enormous resources of crude materials which can be utilized in the manufacture of all classes of munitions of war. As was mentioned in this journal on December 25th, 1914, the chairman of the A. E. G., in addressing the shareholders at the annual meeting which was held in Berlin a fortnight previously, announced that the company—and his observations were directed to the electrical industry in general—had accommodated itself to the situation brought about by the war and had found in the home market compensation in new branches of manufacture for the temporary loss of export business. This statement was naturally only applicable to manufactures for war purposes, but an illustration of what might be expected with regard to certain raw materials for the chemical industry was given by Prof. Grossmann, the Berlin chemist. As reported in the German journal, the professor remarked that the chemical industry was confronted with many new problems in order to provide substitutes out of the existing materials in the country for the many raw chemicals which no longer entered from abroad owing to the operation of the British blockade; and he expressed confidence that where scientific and technical questions arose they would be solved. Apparently the professor was already aware of the work which was then in progress in this direction, as the solution of one important problem in the chemical industry is now reported to have been accomplished with the financial assistance of the government since the outbreak of the war. It is true that this claim only relates to one industry or to one section of it, but on the general question of raw materials there has just become available a statement which was made on behalf of the German Ministry for War before the Budget Commission of the Reichstag on March 15th. On that occasion the representative of the Ministry, replying to a question as to whether the conduct of the war could be prejudiced through a scarcity of raw materials, is reported to have stated that there was no occasion for concern in that respect.

It may be well to see what are the raw materials which Germany has hitherto imported, and which would be and are required for war purposes, and to examine the measures which are asserted to have been adopted in order to overcome the difficulty. The imports have comprised copper, lead and certain other metals, textile materials, chemicals, and explosives in particular. Although having made preparations for many years past in the provision of heavy guns, small arms and both classes of ammunition, the Teutons now admit that on the occurrence of the war they were unprepared with regard to extensive stocks of imported raw materials, which they probably thought would still be procurable under the protection of the navy on the advent of hostilities. But as their battle fleets were taken by surprise through the early action of the British navy, the German government formed in the middle of August a War Raw Material Division to regulate the available raw materials then in the country, prevent waste and secure the proper distribution, so that all works and establishments entrusted with military and naval orders would be able to fulfill their obligations as far as possible. Within a few days replies from 900 firms had been received to circular questions, and by the end of August the total amount of all the stocks of necessary materials of war existing in the country had been ascertained. The curious fact in this connection is that although the State nominally took possession of the stocks, the difficulties in the way of dealing with them were so great that the owners in each branch were requested to constitute themselves into companies, of which sixteen were formed, to undertake the collection and appropriate distribution under the supervision of government officials. The collection necessitated a reorganization of the industries so as to restrict the production of articles of peace as far as was necessary, and steps were also taken by each company to recover old materials, to test and use substitutes, produce by-products and artificial raw materials by the application of the most recent technical and chemical inventions and to promote the import trade to the fullest possible extent. If the import trade is left out of consideration, although large quantities of raw materials have reached German through neutral countries in recent months, the results of the combined work of the government and the special companies concerned since last September are remarkable, if the Teutonic statements faithfully represent the situation of affairs. In the first place, a bill has been introduced to create a trade monopoly in nitrogen until 1922, and the preamble states that a nitrogen industry has been brought into operation, with State assistance, since the outbreak of war, and that it is able to meet the requirements of agriculture and industry in the future. We believe this refers in part to the works established at Oppau in 1913 for the synthetic production of sulphate of ammonia on the Haber process, the works having been started with equipment for an output of 130,000 tons per annum. In general, the use of inland chemicals is said to have resulted in the discovery of a substitute for explosives, while the nitrate requirements for agricultural purposes have to a considerable extent found replacement in synthetic ammonia and cyanamide. The stocks of copper, owing to the large imports in former years, are declared to be so considerable that there is no danger of any scarcity—an assertion which implies that all copper goods or copper alloys in existence are to be used—while tin-plate has been substituted for aluminium, steel for brass, galvanized iron for copper alloy, and iron for electric light leads. In addition, large quantities of copper and of iron ore have been seized in Russian Poland, and copper, zinc, nickel, graphite and ferro-manganese in Belgium and France. The opening of the war placed in the possession of Germany the centers of the textile industries on the European continent, and it is stated that the wool and woolen goods seized represent a value of £25,000,000. It is unnecessary to proceed with any further details beyond mentioning the assertion that important stocks of nitrate were taken possession of at Antwerp, Ostend and Bruges, together with large quantities of rubber, wool, cotton, flax, hemp, yarn, hides and leather, and these are being transported to Germany in trains daily, now that the railways and bridges in Belgium have been repaired.

While we are quite ready to believe that an enormous quantity of material has been seized both in Belgium and in France, and that various metals in Germany have been substituted for others which are required for the purposes of war, we yet come to the conclusion that many of the statements which have been set forth are greatly exaggerated to deceive other countries. If this were not the case, there would not have been such a great outcry against the stoppage of the import trade, and there would be no necessity to hunt everywhere for all classes of metals or to offer rewards for the recovery of spent cartridge and shell cases and the reporting of any finds of live shell, together with broken military accessories of all kinds, on the site of battlefields. We do not wish to underrate the enormous resources of Germany, but as a veto has now been placed on the export of coal and a further body of miners was withdrawn from the Westphalian coalfields in February for service—possibly also from the ironworks and other factories—it would appear that a further step has been taken in the downward trend of production.—*The London Engineer.*

Cost of Electric Steel Making Furnaces

It is stated that experience with electric steel making furnaces in England has demonstrated that, while the size of the furnace has an important bearing on the energy consumption, as the larger furnaces have less radiating area as compared with the weight of the charge than smaller furnaces, there is really not much difference in the actual power needed when doing the same work in the different types of the better known furnaces, and when deciding on which type of furnace to install, the questions of the initial cost of the plant, its suitability for running off existing power supplies, the cost of repairs to the furnace, and the ease with which these can be carried out, are all points which are as important as the question of low power consumption.

Where the Mathematician Could Aid the Astronomer*

The Desirability of Co-operation Between Different Branches of Science

I BELIEVE that it is true that the astronomer has broken more completely with ancient tradition than has the mathematician. Many of the latter are still inclined to take what may be called the artistic view of their work; they refuse to admit that mathematics is a means to some other end, and they frankly assert (half in jest and half in earnest) that their science need have no reference to material things. A few years ago a prominent mathematician, speaking I think from the very chair that I am vacating to-day, quoted with sympathy the sentiment that mathematics is born and nourished out of the play instinct of mankind. It is difficult for me to see the difference between this view and the view that a chess player takes of his game. In the one we may start if we like with a set of axioms and an arbitrary set of postulates without inquiring whether they apply to the world around us, and we may then amuse ourselves by tracing the consequences. The chess-player does this very thing: he sets out with a set of axioms that he calls rules and a set of postulates that he calls openings, and after the expenditure of much thought and ingenuity he is able to trace the consequences.

It is understood, I hope, that I have been speaking in averages. By no means all astronomers have gotten rid of the artistic notion in their work, and by no means all mathematicians have severed their connection with the real world by applying the square-root of minus unity. But there is no denying that the idea of co-operation in a broad sense has not yet taken a strong hold in mathematics. Whether as great advantage would flow from co-operation between one mathematician and another, as is the case in astronomy, it is not for me to say. But when we come to speak of co-operation between mathematics and the other sciences, the benefits that would follow are difficult to overestimate. Let me spend a few minutes in pointing out how greatly the help of the mathematician is needed in a single astronomical subject, namely, that which concerns spectroscopic binaries. If in these remarks I emphasize individual stars, Algol for example, you will understand that these are types of a large class, and that the problems they present are of cosmical importance.

The first star to be recognized as variable in its light was probably Algol. The Arabs seem to have made this discovery, for it is difficult to account otherwise for the very apt name they gave the star, Algol, or El Ghoul, the changing spirit or demon. The same discovery was independently made by others, among them Goodricke of England in 1782, when he was 18 years of age. Goodricke continued to observe the star until he had determined the period and the nature of the light changes, and he advanced what we now know to be the true explanation of its changing light, namely that Algol is periodically eclipsed by a darker companion of nearly the same size as itself. This conjecture was a very bold one in that day, for we must remember that binary stars were then unknown. A great many double stars had been detected, but it was supposed that these were the result of perspective and chance. It was about this time that Michell showed that on the doctrine of probabilities double stars were too numerous to be fortuitous groupings in all cases, so that binary stars were in a sense discovered by a mathematician and not by an astronomer. Twenty years later Herschel proved at the telescope that some double stars are real binaries, and that they revolve around each other by reason of their mutual attractions.

In 1880 Pickering showed that Algol's changes in light conform well with the eclipse explanation, and he suggested that the matter might be settled by the spectroscope. He argued that the orbital velocity of Algol due to the attraction of the dark companion should be considerable, and should change its sign according as the observations are made before or after the time of minimum light. The spectroscope was not quite ready at that time to handle problems of such delicacy, but a few years later Vogel succeeded in greatly increasing its accuracy for the determinations of velocities, by substituting the photographic plate for the human eye. Algol was among the first stars to be tested by Vogel, and his observations indicate precisely such velocities as the eclipse explanation implies. This explanation has been accepted without reserve since that time, and has been extended to all the numerous variables of the same kind that have in the meantime been discovered.

It was early noticed by Argelander and others that the period of Algol, the time between two successive light minima, is not constant. Attempts were made to represent these inequalities by formulæ involving the second and higher powers of the time, but the star refused to conform to such equations. In 1888 Chandler examined this question with great thoroughness; he showed that by the introduction of *periodic* terms all the observations up to that time could be well represented. The most important of these terms has a co-efficient of 173 minutes and a period between 130 and 140 years. To account for this Chandler supposed that the system contains a third body, and that Algol and its eclipsing companion revolve around the common center of gravity of all three bodies in this long period. The dimensions of this orbit were supposed to be such that the light equation in it for an observer on the earth would be 173 minutes, and thus the eclipses would be advanced or delayed by this amount, according as they occur on the nearer or the farther side of this vast orbit. Chandler was quick to see that this explanation entails irregularities in the proper motion of Algol, and that these might be large enough to be unearthed from meridian observations. An examination of all the material of this kind then available convinced him that such an effect is really present, the co-efficient of the oscillation coming out 1.3 seconds, and its period 131 years. This result was apparently confirmed in a general way by Searle at Harvard Observatory, making use of additional observations secured for this express purpose. Baushinger, however, after applying to the catalogue positions the best available systematic corrections, concludes that there is no evidence whatever of a periodic term in Algol's proper motion. In the following year, Boss overhauled the same observations once more and decided that the probabilities were in favor of the presence of a term with a period of 131 years, but with a co-efficient much smaller than that founded by Chandler, 0.5 second against 1.3 seconds. In later years Boss seems to have changed his mind as to the reality of this term; for in his Preliminary General Catalogue, published in 1910, he treats Algol as though its motion were uniform, although in the case of other stars in this catalogue he devotes much attention to periodic inequalities.

It should be remarked that the absence of an appreciable periodic term in the proper motion does not necessarily imply the non-existence of Chandler's third body, since his theory does not demand any particular co-efficient for this periodic term. The only condition is that that co-efficient must be at least twenty times the star's annual parallax, and thus an accurate determination of the latter quantity would throw some light upon the present question. Unfortunately no determination of the parallax accurate enough for this purpose has as yet been made.

Starting with Chandler's inequality of 173 minutes, Tisserand has attempted an explanation that does not assume the presence of a third body. He shows that if Algol be slightly flattened and if the orbit of the eclipsing satellite be somewhat elliptical, the orbit itself will revolve slowly and uniformly in the same direction as the orbital motion of the satellite. Consequently the eclipses will occur earlier than the average time if the periastron point is in the half of the orbit that precedes eclipse, and later than the average if the periastron point is in the half that follows eclipse. This explanation is beautifully simple, and for a time seemed to be the key to the puzzle. I am able to say, not without some regret, that Tisserand's explanation is no longer tenable. In his memoir the following relation is established:

Period $\times$ eccentricity = 3.1416 $\times$ the inequality. In this case the period is 2.87 days, and the inequality found by Chandler is 173 minutes; an eccentricity of 0.13 is therefore demanded, but this is out of the question. A long series of spectrographic observations made at the Allegheny Observatory shows conclusively that the eccentricity of this orbit can not possibly be as great as 0.13, that it is more likely than not to be under one-fifth this amount, and that therefore no inequality greater than 40 minutes can be plausibly accounted for in this way. Shortly after Chandler's formula for the inequality was published, the star (always El Ghoul) thereafter began departing from it little by little, until now the eclipses occur more than an hour later than the formula implies. The character of the inequality is once more in doubt, but as the existence of some kind of inequality is beyond question, this does not lessen the necessity for an explanation.

While the chances in favor of the reality of Chandler's third body have been growing less and less, evidence has been steadily accumulating in favor of an entirely different third body in this system. Since the publication in 1890 of Vogel's classic observations, it has been well known that the radial velocity of Algol is affected by an oscillation whose semi-amplitude is about 40 kilometers, and whose period is the same as that of the light changes, 2.87 days. In 1906 Belopolsky of Pulkova detected the presence of another oscillation in the radial velocity, the amplitude being much smaller than the other, and the period several hundred times as long. Observations made at the Allegheny Observatory have confirmed this discovery in an unmistakable way. The period of this new oscillation is found to be a little less than two years. It could be explained by the presence of a third body of such mass and so situated that the projected distance from Algol to the center of gravity of all three bodies is about two-thirds of the distance from the earth to the sun. It is natural to inquire whether other explanations are not possible, or, in other words, whether the shifts in the spectrum lines from which this third body is inferred may not arise from other causes than changes in velocity. This disturbing question is one that frequently recurs to the mind of the astronomer. Happily, in this case it can be answered in the negative without hesitation. The presence of the third body necessitates a light equation similar to that imagined by Chandler, but now of course with a period of less than two years and with a small amplitude. This amplitude can be computed in advance; we find that it amounts to about 5 minutes of time. I have examined the rich photometric material on this star accumulated in the second half of the 19th century and have found that this light equation is actually present. This seems to leave no doubt that the shift in the spectrum lines is nothing other than an effect of velocity and that the system of Algol contains at least three bodies, only one of which is visible in even our most powerful telescopes.

It is at this point that the man at the telescope must turn to the mathematician and ask him whether this third body can in any way produce the long inequality in Algol's period, that is, in the time that elapses between successive eclipses. If this should be found not to be the case, what dynamical explanations are possible other than those already tested and rejected?

The answer to these questions would doubtless apply to other eclipsing variables, for many of these show similar inequalities in their periods, though as yet in only one other case has the presence of a third body been demonstrated.

A somewhat similar problem is presented by the so-called secondary oscillations that have been announced for certain spectroscopic binaries. If we observe the velocities in a system as carefully as we can, we may draw a curve that expresses the relation between time and velocity. Curves of this sort from various stars will differ widely from each other, but all must conform to certain restrictions, which are in fact those that follow from Kepler's laws. Now for the majority of binaries this is found to be the case, and by assuming that the orbit of the body we have observed has certain dimensions, shape and situation, the velocity curve can be represented within the limits that the accuracy of the observations leads us to expect. But this is not always so: a number of spectroscopic binaries was found for which the velocity curve did not conform to simple elliptic motion. It was then assumed that the system must contain a third body whose attraction causes perturbations in the place and in the velocity of the bright component that we observe. By adopting suitable mass and distance for this body it was found possible to represent the velocity curve fairly well. Too much emphasis should not be placed upon such a representation, however; the assumption of a third body is very much like the adoption of additional pairs of Fourier terms in an empirical formula, and it would have to be a velocity curve of very complex form that did not resemble, within plausible limits, one of the great variety of curves that so many terms would yield.

It has developed recently that many of the cases in which secondary oscillations were apparently present could be explained as a systematic error of observation. This is caused by the presence on the plates of the spectrum of the fainter component which sometimes blends with that of the brighter in such a way as to distort the measures. Leaving out of account all the stars whose secondary oscillations can be explained in this way, we find that practically all the remaining cases are also variable in their light, but not in such a way as to permit the eclipse explanation to apply. This circumstance causes the observer once more to inquire whether the shifts in the spectrum lines that he observes are always velocity effects, or at any rate whether they are due to orbital motion. These remaining cases have another peculiarity; the period of the secondary oscillation is always found to be either just one half or just one third of that of the principal oscillation. If we interpret this in terms of a third body we have a system in which the three components are close together and revolve around each other in simply commensurate periods. It

*From an address by Prof. Frank Schlesinger at the Annual Meeting of the American Association.

is for the mathematician to say whether such a system can be stable, and therefore whether such a third body is possible. Although this is a problem of many years' standing it has not yet been approached from the mathematical side, so far as I am aware. It seems probable to the speaker that such a system will be found to be unstable, for reasons similar to those that account for the dark divisions in Saturn's rings and for the gaps in the distances of asteroids from the sun, these divisions and gaps corresponding to places where the periods would be simply commensurate to that of one of Saturn's satellites in the one case, and to that of Jupiter in the other. It is worthy of remark that in not a single instance where a third body has been inferred from a commensurate secondary oscillation, has this body been confirmed by a subsequent detection of its spectrum or otherwise. It is true that in Lambda Tauri two oscillations, both of short period, have been detected; but these periods seem to bear no relation to each other.

A mathematical problem connected with binaries, more important than either of the above, has to do with the origin of these systems. This is one of the few problems in sidereal astronomy with which the mathematician has concerned himself to any great extent, but it is still far from being in a satisfactory state. The past history of the moon, in a dynamical sense, formed the subject of an exceedingly laborious investigation by George Darwin more than 30 years ago. He concluded that the earth and the moon had once formed a single body and that they had broken away from each other by a kind of fission induced by the rotation of the body on its axis. Tidal friction is now set up; it causes the two bodies to draw away from each other, the month to become longer and the orbit of the moon to become somewhat eccentric. Darwin and others have extended this reasoning to double stars, and here the recent work on spectroscopic binaries seemed to afford a striking confirmation of the theory. It has been found that close binaries almost invariably have circular orbits and that their physical condition, as revealed by their spectra, is of the sort that is generally accepted as indicating youth. Widely separated binaries, on the other hand, are apt to have eccentric orbits and to show signs of old age. Still more recently the mathematical side of the question has been reviewed by Moulton, Jeans, Russell and others. It now appears that Darwin's results are at least incomplete and that the causes he adduces are not sufficient to account for the genesis of the moon or for that of double stars. The chief difficulty is that tidal friction is not competent to drive apart to any great distance two bodies of comparable mass that have separated by fission. It appears probable in this view that the separation must have occurred long before the bodies formed stars, that is, while they were still nebulæ. The difficulties of reconciling certain observational facts with this view are great, but it would be out of place to recount them here.

We see that binary systems offer a rich field for the labors of the mathematician. Other subjects in astronomy are equally inviting, and I have no doubt that other sciences have as much to offer. An eminent psychologist, for example, has said that the time has come for a great mathematician to concern himself with psychological problems. There is a proverb to the effect that to him that is well shod the whole earth is covered with leather. And so the mathematician may walk where he pleases. What particular path he chooses is not a matter of great importance, but it is important that he be abroad and doing, and that he do not sit at home admiring his shoes.

Science has often been likened to a warfare, and such a simile as this naturally recurs to the mind at this time. We may think of science as at first occupying a small domain surrounded by the vast territories of the unknown. In the early days it was easier than now to add to this domain. A single bold spirit, starting out in almost any direction, could often wrest much from the adversary. But as the domain of science increases, so also do the extent and diversity of its boundaries. The more obvious points of vantage are already taken and the character of the warfare must change. The day of guerilla warfare is gone, it is now necessary to act in larger groups and for each man to be willing to serve at the side of others. This policy often requires the suppression of personal ambition, and deeds of individual heroism become less frequent; but great victories are to be won in either kind of warfare only if the soldier is imbued with such a spirit as this.

Kinds of Coal Produced in the United States

The statistics for 1913 show that in addition to the 81,718,860 long tons (91,524,922 short tons) of anthracite produced in Pennsylvania, 35,416 short tons of this grade of coal were mined in Colorado and 34,345 tons in New Mexico. The principal production of semi-anthracite is from Arkansas, with smaller quantities from Oklahoma, Colorado, and Virginia. The production of Sullivan County, Pennsylvania, is included with the anthracite production of that State, though its classification as anthracite is a matter of some contention. This item amounts to about 600,000 short tons annually. West Virginia leads in the production of semibituminous coal, with Pennsylvania second, Maryland third, and Colorado fourth. West Virginia also leads in the production of split coal, and Kentucky is the only other State credited with any of this product in 1913. Cannel coal was reported from seven States in 1913, Kentucky contributing nearly two-thirds of the total. Kentucky also took first place in the production of block coal in 1913, displacing Indiana. These two States yielded over 90 per cent of the total production of block coal. Wyoming is the principal producer of subbituminous coal ("black lignite"), 60 per cent of the State's total being of that grade, and Colorado ranks second, with Montana third and New Mexico fourth. All of the output of North Dakota and nearly half of that for Texas is lignite or brown coal. Bituminous coal is produced in every State having a production of 100,000 tons or more, with the exception of North Dakota.—*Mineral Resources of the United States for 1913, Department of Interior.*

World's Shipbuilding

It was not to be expected that the record in shipbuilding established in 1913, both at home and abroad, would be equaled last year. The annual return compiled by Lloyd's Register shows that in the United Kingdom the output of merchant vessels declined by 248,600 tons, while the figures for all foreign countries (which are, however, necessarily incomplete) show an apparent decrease of 231,000 tons.

That Britain's great lead in ship construction was easily maintained will be seen from the following table, giving particulars of last year's production at home and abroad:

	United Kingdom.		Other Countries.	
	No.	Tonnage.	No.	Tonnage.
Steamers	621	1,674,358	473	1,111,027
Sailing ships	35	9,195	190	58,173
Totals	656	1,683,553	663	1,169,200

Of Britain's total output over 75 per cent, or 1,273,530 tons, was built for registration in the United Kingdom. The amount of tonnage launched for other countries was 410,023, forming 24⅓ per cent of the total output, as compared with over 21½ per cent in 1913 and nearly 24 per cent in 1912. Tonnage intended for the British Colonies amounted to 36,736. Of other countries, Holland provided the largest amount of work for the shipbuilders of the United Kingdom, namely, fifteen vessels of 88,097 tons (nearly 5¼ per cent of the total output). Norway occupied the second position with 67,827 tons, being followed by Greece with 41,543 tons, and Belgium with 35,951 tons.

Steamers continue to increase in size. Excluding vessels of less than 500 tons, the average of the remaining steamers reached 4,460 tons gross, a considerable advance on the averages of the five preceding years. Seventy-one vessels of 6,000 tons and above were launched. Of these, thirteen were over 10,000 tons each, the largest being the White Star liner "Britannic," of 47,500 tons; the Holland-Amerika liner "Statendam," of 32,500 tons; and the "Belgenland," of 26,500 tons.

Among shipbuilding centers the Clyde district occupied the first place, showing an output of 444,621 tons (Glasgow 288,103 tons and Greenock 196,518 tons). Then follow the Tyne (315,585 tons), the Wear (277,528 tons), Belfast (239,819 tons), Middlesbrough (137,165 tons), and Hartlepool (124,419 tons).

At the end of December there were under construction, including a number of vessels already launched but not completed, fifty-seven vessels of between 6,000 and 10,000 tons, seven of between 10,000 and 15,000 tons, ten of between 15,000 and 20,000 tons, four of between 20,000 and 40,000 tons, and one of 47,500 tons.

Germany heads the list of foreign countries with an output of 387,194 tons, followed by the United States with 200,762 tons, Holland with 118,153 tons, and France with 114,052 tons. Germany's production shows an apparent decrease of 78,000 tons. Twenty-eight steamers of between 5,000 tons and 10,000 tons were launched in that country during the year, and six of over 10,000 tons. The largest was the Hamburg-Amerikan turbine liner "Bismarck," of about 56,000 tons gross, launched at Hamburg, one of the two biggest vessels now afloat.—*The London Daily Telegraph.*

Salts Colored by Cathode Rays

In a paper read before the British Association, in Australia, E. Goldstein states that it has long been known that salts bombarded by cathode rays become discolored. This was ascribed by Giesel to partial decomposition of the salt, resulting in the reduction of some of the metal. But the present author found this discoloration may occur in the absence of all metals and in inorganic compounds containing chlorine, bromine, etc. It is here suggested that there is no real reduction, but that the compounds are *distended*, i. e., that the bands between them are loosened. In this distended condition, common to all the elements, matter has a high absorptive power for light. The colors are producible by a very short exposure to cathode or β-rays or to ultra-violet light, to which last agency the real effect is here ascribed. A connection appears to exist between these phenomena and the therapeutic effect of radium and mesothorium in the treatment of skin and other diseases.

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